THE

Practical Teacher

A MONTHLY EDUCATIONAL JOURNAL.

Edited by JOSEPH HUGHES.

'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

VOL. VI. No. 5. JULY, 1886. PRICE, 6D. POST FREE, 7½D.

Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.).

HOW TO PREVENT DISEASE IN SCHOOL AND HOME (*continued.*)

Scarlatina (*continued.*)—The inunction must be used very gently, as it is possible to do much harm by injudicious severity. I have seen more than one case in which the poor patient became the subject of an acute attack of eczema in consequence of the persistence of the nurse in rubbing the body with the oil. She had misunderstood the object of the application. It is not to rub in the oil, but to moisten the scales and skin dust, so as to prevent it escaping from the bed and pervading the ward, and then passing from the ward into the outer air before its vitality has been destroyed. It is probable that the vitality of the scarlatina germ is considerably less than that which belongs to the active germ of small pox, and that its infective character subsides very quickly after it has left the patient, whilst the vitality of the resting spore is also considerably less than that which belongs to the crust from the small pox pustule. The inunction should be commenced about the fourth day of the eruption. I strenuously object to the scrubbing which has been strongly recommended by some hygienists as necessary. A gentle inunction is all that is required, much harm has been done by too great zeal in this direction, both by friction and the consequent exposure to the colder air. As soon as the fever stage has passed and the thermometer has indicated a normal temperature for the past 24 hours, a warm bath may be employed, and then some carbolic soap will be useful to remove the grease and adherent flakes of skin. These actions are however, only to be taken with the advice of the medical attendant, and not by the nurse without such permission. The bath should be used every other day, allowing the patient to be in the water, on the first occasion for a few minutes only and using gentle means for drying the body, the patient resting between the blankets afterwards for an hour or two, so as not to necessitate the immediate removal of all dampness from the skin by friction. A longer immersion may be indulged in on each succeeding occasion. The baths should be continued until all traces of scales have been removed from the body. It is a good plan to begin with a temperature of 90° and to lessen the heat by one or two degrees on each succeeding occasion, so that the bath is a tepid one at the end of the week, and a cold bath (about 65°) as soon as perfect convalescence is established. The body should be anointed with oil about an hour after the bath has been taken and the inunction repeated until the scaly state of skin has been entirely removed. The same course must be taken as regards hair cutting, and washing out the apertures of the body, as has been enjoined in the case of small pox. As soon as the cold bath stage is reached, a solution of Condy's fluid may be used as before directed, and if there are no sores or eruptions about the body, and if there is no evidence of albumen in the urinary secretion, the patient may go out of quarantine. It is an important point in regard to convalescents from scarlet fever that the urinary discharge should be natural in its chemical composition. No person should be allowed much liberty until the skin has recovered its softness, and the kidneys secrete normal urine. The condition of the skin is so altered in the feverish stage, and its functions so interfered with by the scarlatina eruption, that the patient remains for some time very sensative to outside influences. There is always in such cases a tendency, more or less, to congestion of the kidney which is brought into activity by slight chills, and inflamation is easily established. This is the greatest danger to convalescents from scarlatina. Its existence is sometimes suddenly manifested by the onset of convulsion or general dropsy, and the patients life is placed in imminent danger, though the attack of scarlatina might have been of the slightest character. For this reason it is very important to keep scarlatina convalescents from exposure to cold draughts, and impure atmosphere. These causes, either separately or combined, are those which most frequently set up mischief in the kidney, and usher in convulsion and brain complications of various kinds. The length of time during which the patient should be in quarantine will vary according to the severity of the case, and the nature of the complications which may have arisen. If there has been none, and the case has

BRITISH MUSEUM

presented the mildest form, it may be possible for the patient to mix with his fellows again at the end of a week from the departure of the feverish stage. Ten days will be ample in most uncomplicated cases, but if there has been any abscesses or eruptive sores in any part of the body, during, or immediately after the subsidence of the fever, it will not be safe for the patient to be let out of quarantine until a much longer period has elapsed and the sores have healed. If there has been any kidney mischief, it will not be prudent to allow of a return to ordinary life, until all trace of albumen has departed from the urinary secretion. If there has been much activity of the disease about the throat, it will be requisite to have it restored to a perfectly healthy condition before the patient is let out of his retirement from the world. The rules which have been laid down for the conduct of the nurse in the management of the sick room apply as much to scarlatina as to small pox.

I am accustomed to recommend that the atmosphere of the room should be charged with the vapour of creasote or carbolic acid. These hydro-carbons have a good effect in diminishing the rapidity of reproduction of the germs which spread the disease and their vapours are manifestly advantageous in checking fungoid growths of all kinds. It is a good plan to have pieces of flannel dipped in creasote or carbolic acid hung up in different parts of the room, occasionally moistening them with fresh portions of the reagent as they become dry, at the same time ventilating thoroughly so that the air shall not be super-saturated. The floor should be mopped over two or three times a day with a mop which has been damped in a weak solution of carbolic acid, but the floor must not be thoroughly wetted. The mop should especially be passed under the bed so that the floor in that part of the room may have all dust removed from it. Indeed the floor, the furniture, and the hangings of the room must be treated so that no particle of dried skin can be preserved, which might in the end lead to the establishment of another set of cases. It is possible for the germs or resting spores of the disease to be preserved in books and among puzzles or other objects which may have been used for the amusement of children. No books of value should be used by scarlatina patients, it is better to have all such things burnt when the patients have recovered and have done with the objects in question.

When cases of scarlatina have been treated at home, it should be satisfactorily determined as to the source of infection; if this be established and the cause be not one likely to recur, there is no reason why the house should not be thoroughly disinfected, and rendered inhabitable again in a very short period after the patients have recovered. This is the more likely to be the case if the disease has been introduced by infection from a distant case. All washable articles being removed from the room, the bedstead brought into the centre of the room, with other articles which cannot be easily removed for disinfection elsewhere. The floors, the walls, and the ceilings should be scoured, and the latter lime-whited either before or after the room has been fumigated. This latter operation is effected by bringing into the room a slab of stone, like to a Yorkshire paving stone; an ordinary hip bath or similar tub should be placed upon the stone, and a few inches of water put into the vessel. An iron brasier or tripod placed in the water, and a spirit lamp containing bisulphide of carbon (about four or six ounces according to the size of the room) placed in the brasier. The windows should be closed, all crevices shut up by having brown paper pasted over them, the keyholes stopped and every chink or opening of any kind closed so that no air can get in or out of the room. Everything being ready the wick in the spirit lamp should be lighted and the room shut up as quickly as possible. The bisulphide of carbon burns away, filling the room with sulphurous acid vapour; this pervades the room and destroys all living organic matter which may be within the four walls. If bisulphide of carbon is not at hand or the workmen employed unskilled in its use, it is better to burn about half a pound of stick sulphur, made up with pieces of wood, and so arranged as to obviate the possibility of setting the house on fire. Bisulphide of carbon is a dangerous article to be handled by those who do not understand its nature. Care must be taken to close the chimney as well as all other openings. This may be easily effected if there is no register to the stove, by a bundle of straw in a sack or other bag, stuffed up the opening.

The room should be kept shut up for 24 hours. On the following day it may be opened, thoroughly ventilated, washed down, cleaned, and white-washed, and it will then be fit for occupation again without any risk to the new inhabitants.

I have been particular in this description because an immense quantity of so called fumigation is inefficiently done. If it is done at all it should be well done, and not done in a make believe manner, as is but too often the case.

The course recommended when fumigation is to be used, is the same whatever may have been the character of the infectious disease in the house, but it more especially applies to small pox, scarlatina, diphtheria, erysipelas, and puerperal fever.

The stage of incubation for scarlet fever is much shorter than all other infective complaints. It may develope in 24 hours or not, until after six days have elapsed. I doubt the known origin of the case if a longer period is supposed to have elapsed from the period of infection. The causes of scarlatina are so various, it is spread about by so many different agencies that it is difficult at all times to arrive at a correct solution of the causation in every case. I have known it spread by means of sewer gases in ways which pointed out the fact that though the cause ceased, the effect continued in a secondary manner. I investigated a series of cases which commenced in a school at the top of a hill, in which the only outlet for sewer gas from an immense sewer was under the floor of the school room of the boys and infants, these only being at first affected. The schools were closed but the epidemic continued for seven weeks afterwards. It was seen in the end that those children only who had been in the schools when the sewer gas was manifest were affected, they alone caught it from the children first affected. The disease did not spread to other children in the district, though there was no real attempt at isolation, and all mixed together in the houses and streets. The disease did not affect the girls who had not been exposed to the sewer gases in the school, though they mixed with the affected children. This curious case pointed out the fact that the disease is not nearly

so infective to those who have been breathing a pure atmosphere, but that those who have been in foul air much more easily take on an infective complaint when they come into contact with those who are actually suffering from the disease in question. It may be spread abroad by means of food, especially milk, and it is undoubtedly catching from one to another, both in the feverish and the convalescent stage, but as I have before remarked, its extension from case to case is limited to short distances only.

Diphtheria.—The course to be pursued in cases of this disease correspond very much to that which has been laid down for scarlatina. Our knowledge of its behaviour is more limited than is the case with either small pox or scarlatina, whilst it appears much more difficult to eradicate it from those houses in which it has appeared. It is very infectious from individual to individual. Those nursing cases of it are susceptible, and may become the victims of it. Many medical men have been infected whilst performing the operation of tracheometry; mothers have been infected whilst nursing their children, none are safe as it does not appear that one attack preserves the individual from a possible second illness from the same cause.

(To be continued.)

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How to Earn the 'Excellent' Grant.

By One of Her Majesty's Inspectors of Schools.

THE TEACHING OF HISTORY.

INSTRUCTION in history in elementary schools naturally falls under two heads. 1. The use of Historical Readers in Standards III. to VII. 2. Teaching of history as a class subject. We have not much to say under the first head; yet, as not a little misunderstanding has been created on this subject, it is important that there should be explicit understanding amongst teachers as to the use of an Historical Reader. Her Majesty's inspectors are supposed to treat it as an ordinary reading book; that is to say they are called upon to require the scholars not only to read selected passages from it but to answer questions bearing on the context. Questions involving a knowledge of a whole historical period or connecting the chapter selected for reading with the previous or succeeding chapter are not admissible. While it may be fairly conceded that such limitations upon the knowledge of the History Reader by the scholar are just, teachers are not for one moment called on to treat the History Reader merely as a means of securing fluent reading, a knowledge of the meanings of words, and of the relation of one thought to another in any given passage. Teachers would be much better advised whilst distinctly disclaiming the attempt to teach either chronology or the unimportant minutiæ of historical facts to so interest their classes in the leading personages of history and its broad constitutional facts as to make the History Reader of real value to them as the sons and daughters of British citizens, and the men and women of the future in whose hands will largely rest the elevation or downfall of the British Empire. The teacher will therefore do well himself to make a digest of the History Readers, which will enable him to draw the attention of his classes to their salient features.

2. Where history is taken as a class subject the teacher could not do better than acquaint himself thoroughly with that chapter in Mr. Fitch's Cambridge Lectures which deals with history, for it contains in a small compass the best statement that we have yet read upon the difficulties which a teacher has to encounter in dealing with the subject, and the most successful methods which have been pursued to surmount them. It is the general experience of her Majesty's inspectors that history has been taught in a too mechanical manner under the new Code.

The scholars have learnt their dates, and often far too many dates, parrot fashion, and they will answer your questions upon wars, statutes, and the social life of the people in language so identical that the inspector's suspicion is at once aroused, and on inquiring he learns that these answers are learnt by rote, either from notes given by the teacher or from small historical text-books. Instruction like this is no better than cram.

But, it may be urged, why teach English history at all in our Elementary Schools? What practical knowledge of history are children to gain by 13 years of age? And then our school history books, crammed as they are with facts, and written as a rule in an utterly dispassionate style, can they engross the imagination or even secure the interest of the scholars? A taste for history certainly is likely to be keener as boyhood is passing into manhood, and the young Englishman recognises that the time has come for him to enquire into the meaning of English citizenship, and to ponder the causes which have made the name of Britain admired and feared and beloved through the four quarters of the globe. But all study to be of real value must be systematic, and what proportion of the masses can you expect to teach themselves history on such lines? One reason, therefore, for teaching history in our schools is that it is not likely to be learnt after the school life is over; or if it be learnt, it would be half learnt from partizan books and partizan papers.

Again, the plea that our school books are not attractive merely affects the method of teaching history. Too much reliance should not be placed upon the text-books of the kind above indicated, but the interest of scholars should be aroused, stimulated, and sustained by good oral teaching; and good oral teaching implies the saturation of the teacher's mind with the romance as well as the reality of English history. Our word story is short for history. The teacher who can tell the story of English history simply and eloquently will make the subject a delight to his hearers. But how accumulate the material for this method?

The teacher of a middle-class school or a higher grade Board School should be master of the List of Biographical Monographs on page 383 of 'Fitch's Lectures on Teaching.' But to the more elementary teacher Miss Yonge's books will supply the element of noble romance so valuable to young minds, and J. R. Green's 'Short History of the English People' will place the history of our constitutional struggles and victories before them in the most attractive light

possible. Being thus armed for his work, *where* should the teacher begin? At the beginning of the history period through which his class has to go? Certainly not. It will be found that each period is dominated by some central figure or derives its interest from some great central fact.

Take that central figure and make him the hero of your class. Show how the times waited for him, needed him, were blessed by him. Or how, when he obtained power, he grew slack or ambitious, and relaxed the reins of good government, or tightened them into tyranny. Or if a great central fact has to be recorded such as Magna Charta, paint the picture of the people as they lay groaning under the tyranny of John; contrast the lot with which they were cursed with the blessings which we enjoy. If the past be thus connected with the present in relation to facts, and heroic characters be brought home to children's hearts in the manner just suggested, there will be no difficulty at all in gaining their interest in the leading features of English History.

When this has been achieved the rest will be easy. The connecting links between one vital event and another can be supplied without much difficulty, and a reasonable number of dates acquired by the scholars in distinct relation to the central figures, and to the central facts. It is well said by Mr. Fitch that the Bible, which is the best of Histories, is in the main biographical, and social habits and customs, laws, and even doctrine, are all made subservient to the life actually led by our Great Exemplar, and the law-givers, prophets, and kings who preceded Him, and the apostles who followed Him. We are warned, however, and rightly, to make historical teaching sufficiently definite. It must not be idealised away by too entire a reliance upon the picturesque method of teaching.

The practical outcome of a great man's life, whether he be good or bad, should be insisted upon, lessons on the Government and Constitution of England, and lessons on the duties as well as the rights of citizenship should be carefully given.

The relation between events and places should be shown by continual reference to the map, and the connection between one event in history and another should be kept up in the scholars' memories by frequent recapitulation and constant insistence upon their causes and results.

Such a method of teaching can only be carried out by a master or mistress full of the subject, and therefore in the habit of talking it over without any help from a dry text-book; one who is always ready with an apt passage from Shakspere's Historical Plays, or from one of our great historical writers, whenever colouring matter is required to lend vividness to a scene or life to a character. Such teachers are undoubtedly rare, but we think they would be less rare if school-masters and school-mistresses would only give the system here advocated a full and fair trial.

(To be continued.)

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Easy Steps in Trigonometry.

BY REV. A. D. CAPEL, M.A.,

Author of 'Catch Questions in Arithmetic,' etc., etc.

ANSWERS AND HINTS TO SOLUTIONS.

CHAPTER VII.

1. If we write $(-y)$ for y in $\sin(x+y) = \sin x \cos y + \cos x \sin y$, we get $\sin(x-y) = \sin x \cos(-y) + \cos x \sin(-y)$, but $\cos(-y) = \cos y$ (Form. 24) and $\sin(-y) = -\sin y$—(Form. 23.)

$\therefore \sin(x-y) = \sin x \cos y - \cos x \sin y.$

2. $\text{Tan}(x+y) = \dfrac{\tan x + \tan y}{1 - \tan x \tan y}$

Let $y = -y$; $\tan(-y) = -\tan y$. Form. 25.

$\therefore \tan(x-y) = \dfrac{\tan x - \tan y}{1 + \tan x \tan y}$

3. $\text{Sin } x + \cos x$

$$= \begin{matrix} 0^\circ \\ 0 \end{matrix} + \begin{matrix} 30^\circ \\ \frac{1}{2} + \frac{\sqrt{3}}{2} \end{matrix} \Big| \begin{matrix} 45^\circ \\ \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} \end{matrix} \Big| \begin{matrix} 60^\circ \\ \frac{\sqrt{3}}{2} + \frac{1}{2} \end{matrix} \Big| \begin{matrix} 90^\circ \\ 1 + 0 \end{matrix} \Big|$$

$$\begin{matrix} 120^\circ \\ \frac{\sqrt{3}}{2} - \frac{1}{2} \end{matrix} \Big| \begin{matrix} 135^\circ \\ \frac{1}{\sqrt{2}} - \frac{1}{\sqrt{2}} \end{matrix} \Big| \begin{matrix} 150^\circ \\ \frac{1}{2} - \frac{\sqrt{3}}{2} \end{matrix} \Big| \begin{matrix} 180^\circ \\ 0 - 1 \end{matrix}$$

$$\text{or } \begin{matrix} 0^\circ \\ 1, \end{matrix} \begin{matrix} 30^\circ \\ \frac{1+\sqrt{3}}{2}, \end{matrix} \begin{matrix} 45^\circ \\ \frac{2}{\sqrt{2}}, \end{matrix} \begin{matrix} 60^\circ \\ \frac{\sqrt{3}+1}{2}, \end{matrix} \begin{matrix} 90^\circ \\ 1, \end{matrix} \begin{matrix} 120^\circ \\ \frac{\sqrt{3}-1}{2}, \end{matrix} \begin{matrix} 135^\circ \\ 0, \end{matrix}$$

$$\begin{matrix} 150^\circ \\ -\frac{\sqrt{3}-1}{2}, \end{matrix} \begin{matrix} 180^\circ \\ -1 \end{matrix}$$

where it will be seen that the value changes sign as it passes through the value 0.

4. $\sin 0^\circ - \cos 0^\circ = 0 - 1$ or -1 whence the value of the expression decreases until the angle reaches 30°, $\sin 30^\circ - \cos 30^\circ$ being $= \frac{1}{2} - \frac{\sqrt{3}}{2}$, after which the value increases until $\sin 45^\circ - \cos 45^\circ$, which is $= 0$. Here the value changes sign, becoming positive, and increases until it comes to its maximum at $\sin 150^\circ - \cos 150^\circ$, which is $= \frac{1+\sqrt{3}}{2}$ whence it gradually diminishes until at $\sin 225^\circ - \cos 225^\circ$ it again becomes $= 0$, whence it decreases to its minimum at 330° when $\sin 330^\circ - \cos 330^\circ = -\frac{1+\sqrt{3}}{2}$ after which it gradually increases, $\sin 360^\circ - \cos 360^\circ$ being $= -1$.

5. Since whether the sine and cosine are respectively positive or negative, the squares of these ratios will be always positive, the sign of this expression will depend only on the numerical relationship of the sine and cosine.

$\text{Sin}^2 0 - \cos^2 0 = 0 - 1$ or -1, whence the value increases to $\sin^2 45 - \cos^2 45$, or $\frac{1}{2} - \frac{1}{2}$ or 0. Here the value changes sign and gradually increases up to 90°, when $\sin^2 90 - \cos^2 90^\circ = 1$. Hence it decreases again down to 0 (viz. at 135°), and changing its sign, decreases still more down to 180°, when the value is $0 - 1$ or -1.

6. $A + B + C = 180^\circ$

$A = 180^\circ - (B + C)$

$\cot A = \cot[180^\circ - (B + C)]$

$= -\cot(B + C)$ Form. 19.

7. If $A + B + C = 180^\circ$

$2A + 2B + 2C = 360^\circ.$

$2A = 360^\circ - (2B + 2C)$

$\sin 2A = \sin[360^\circ - (2B + 2C)]$

$= -\sin(2B + 2C)$

As a figure would immediately show.

8. $A + B + C = 180^\circ$

$2A + 2B + 2C = 360^\circ$

$2A = 360^\circ - (2B + 2C)$

$\cos 2A = \cos[360^\circ - (2B + 2C)]$

$= \cos(2B + 2C)$

as the same figure as drawn for 6 would show.

9. If $A + B + C = 180°$

$$\frac{A}{2} + \frac{B}{2} + \frac{C}{2} = 90°$$

$$\frac{A}{2} = 90° - \frac{B + C}{2}$$

$$\operatorname{cosec} \frac{A}{2} = \operatorname{cosec} \left\{ 90° - \frac{B + C}{2} \right\}$$

$$= \sec \frac{B + C}{2}$$ by definition of the complement, implied in the syllable 'co.'

10. Let ABCD be a circle, CA being the horizontal diameter (A to the right), and BD the vertical diameter (B to the top). Let O be the centre. Draw the diameters POQ (P between A and B), and ROS (R between B and C), bisecting the angles BOA and BOC respectively.

When the revolving line is at PROQS, the sine and cosine are numerically equal. Within the quadrants POR and QOS, the perpendicular will be longer than the base, hence the sines will be numerically greater than the cosines, and in the other two quadrants the cosines will be numerically greater than the sines.

11. From 0 to -90 the cosine gradually decreases from 1 to 0, here it changes sign and goes on decreasing till at $-180°$ its value becomes -1; from this point it increases, until at $-270°$ it becomes 0, when it changes sign and gradually increases until at $-360°$ it becomes equal to 1.

12. (i) $765° = 2 \times 360° + 45°$. $\therefore \sin 765° = \sin 45° = \frac{1}{\sqrt{2}}$

(ii) $675° = 360° + 315°$. $\therefore \sin 675° = \sin 315°$.

$315° = 180° + 135°$. $\therefore \sin 315° = -\sin 135°$

$-\sin 135° = -\sin (180° - 45°) = -\sin 45° = -\frac{1}{\sqrt{2}}$

$\therefore \sin 675° = -\frac{1}{\sqrt{2}}$

13. The only angle between 0° and 360° whose sine is actually $= \sin 70°$ is $180° - 70°$ or 110°, but numerically the sine of the angles $180° + 70°$ and $360° - 70°$, or 250° and 290° are equal to the sine of 70°.

14. The only negative angles between 0 and -360 whose cosines are absolutely $= \cos 40°$, are $-40°$ and $-(360° - 40°)$ or $-320°$.

15. $\operatorname{Tan} -(270° + \theta) = -\tan (270° + \theta)$

$$= -\frac{\tan 270° + \tan \theta}{1 - \tan 270° \tan \theta}$$

dividing by $\tan 270°$ or ∞ $= +\dfrac{1 + \dfrac{\tan \theta}{\infty}}{\tan \theta - \dfrac{1}{\infty}}$

$$= \frac{1 + 0}{\tan \theta - 0} = \frac{1}{\tan \theta}$$

16. $\operatorname{Sin} (90° - \theta) = \sin 90° \cos \theta - \cos 90° \sin \theta$

$= \cos \theta - 0 = \cos \theta$.

17. $\operatorname{Vers} (-315°) = 1 - \cos (-315°) = 1 - \cos 45°)$

$$= 1 - \frac{1}{\sqrt{2}}$$

18. $\operatorname{Tan} \theta + \cot \theta = 2 \sec \theta$.

$$\frac{\operatorname{Sin} \theta}{\cos \theta} + \frac{\cos \theta}{\sin \theta} = \frac{2}{\cos \theta}$$

$$\operatorname{Sin}^2 \theta + \cos^2 \theta = 2 \sin \theta$$

$$1 = 2 \operatorname{Sin} \theta$$

$$\operatorname{Sin} \theta = \tfrac{1}{2}$$

$\therefore \theta = 30°, 150°, -210°, -330°$.

19. $\operatorname{Vers}. 0° = 1 - \cos 0° = 1 - 1 = 0$. Thence the value of the versine gradually increases until the angle arrives at 90° when it is $1 - 0$ or 1, hence it goes on increasing until the angle has arrived at 180°, when it is $1 + 1$ or 2. From this point it decreases until the angle arrives at 360° where it is 0.

20. $\operatorname{Sin} 0° \cos 0° = 0$. $\operatorname{Sin} 45° \cos 45° = \frac{1}{2}$, and $\sin 90° \cos 90° = 0$. $\operatorname{Sin} 135° \cos 135° = -\frac{1}{2}$. $\operatorname{Sin} 180° \cos 180° = 0$. $\operatorname{Sin} 225° \cos 225° = +\frac{1}{2}$. $\operatorname{Sin} 270° \cos 270° = 0$ and $\sin 315° \cos 315° = -\frac{1}{2}$. Hence the value increases from 0 to $\frac{1}{2}$ and decreases from $\frac{1}{2}$ to 0, then further decreases from 0 to $-\frac{1}{2}$ and increases from $-\frac{1}{2}$ to 0, again increasing, &c.

21. Since $\tan 180° = 0$ the expression is always $= 0$ whatever be the value of θ.

22. $\dfrac{3 \sin \theta - 2 \cos \theta}{3 \sin \theta + 2 \cos \theta} = 1 - \dfrac{4 \cos \theta}{3 \sin \theta + 2 \cos \theta}$ and this to be a maximum.

$\dfrac{4 \cos \theta}{3 \sin \theta + 2 \cos \theta}$ must be a minimum which it is when $\cos \theta = 0$ and $\sin \theta = 1$ or when $\theta = 90°$.

$\therefore$ When a maximum $\dfrac{3 \sin \theta - 2 \cos \theta}{3 \sin \theta + 2 \cos \theta} = \dfrac{3 - 0}{3 + 0} = \frac{3}{3} = 1$.

23. $\operatorname{Tan} \tan^{-1} \frac{1}{2} = \frac{1}{2}$ and $-\cot (90° + \tan^{-1} \frac{1}{2})$

$$= -\left(\frac{0 \cdot 2 - 1}{0 + 2}\right) = \frac{1}{2}$$

$\therefore \operatorname{Tan} \tan^{-1} \frac{1}{2} = -\cot (90° + \tan^{-1} \frac{1}{2})$.

24. $\operatorname{Sin}^2 \theta = \dfrac{3 \cos \theta}{2}$

$2 \sin^2 \theta = 3 \cos \theta$

$2 (1 - \cos^2 \theta) = 3 \cos \theta$

$2 \cos^2 \theta + 3 \cos \theta - 2 = 0$

$(2 \cos \theta - 1)(\cos \theta + 2) = 0$

$\therefore \cos \theta = \frac{1}{2}$ or -2 which latter value is impossible.

$\therefore \theta = -60°$ or $-300°$

25. $\operatorname{Tan} \left(\tan^{-1} \dfrac{1}{x - 1} - \tan^{-1} \dfrac{1}{x} \right) = \tan 45°$

$$\frac{\dfrac{1}{x - 1} - \dfrac{1}{x}}{1 + \dfrac{1}{x - 1} \times \dfrac{1}{x}} = 1.$$

$$\frac{1}{x - 1} - \frac{1}{x} = 1 + \frac{1}{(x - 1)\, x}$$

$x - (x - 1) = x (x - 1) + 1$

$x - x + 1 = x^2 - x + 1$

$x^2 - x = 0$

$x (x - 1) = 0$

$\therefore x = 0$ or 1.

CHAPTER VIII.

REDUCING THE SUM AND DIFFERENCE OF TWO SINES OR COSINES TO FACTORS, AND *VICE VERSA*.

116. We now come to eight of the most important Formulas in Trigonometry, which, instead of numbering, I shall letter A, B, &c.

117. $\operatorname{Sin} (x + y) = \sin x \cos y + \cos x \sin y$. Form. 11.

$\operatorname{Sin} (x - y) = \sin x \cos y - \cos x \sin y$. Form. 14.

$\therefore \operatorname{Sin} (x + y) + \sin (x - y) = 2 \sin x \cos y$.

118. The Formula, as it appears in 117, is very well adapted for changing the product of a sine and a cosine into the sum of two sines, thus:

$$\sin x \cos y = \tfrac{1}{2} [\sin (x + y) + \sin (x - y)]$$ Form. A.

119. In Formula A, let $x = \dfrac{a + b}{2}$ and $y = \dfrac{a - b}{2}$

this $\sin \left(\dfrac{a + b}{2} + \dfrac{a - b}{2} \right) + \sin \left(\dfrac{a + b}{2} - \dfrac{a - b}{2} \right)$

$$= 2 \sin \frac{a + b}{2} \cos \frac{a - b}{2}$$

or $\sin a + \sin b = 2 \sin \dfrac{a + b}{2} \cos \dfrac{a - b}{2}$ Form. B,

which can be reduced to words thus:

The sum of two sines is equal to twice the sine of half their sum multiplied by half their difference.

120. Subtracting Form. 14 from Form. 11 we get:
$\sin(x+y) - \sin(x-y) = 2\cos x \sin y$
or $\cos x \sin y = \frac{1}{2}[\sin(x+y) - \sin(x-y)]$
Form. C,
in which x is $> y$.

121. If y is $> x$ — $\sin(x-y) = \sin[-(x-y)]$ $= \sin(y-x)$, and the expression becomes Formula A, x being written for y and y for x.

122. Again let $x = \frac{a+b}{2}$ and $y = \frac{a-b}{2}$

then $\sin\left(\frac{a+b}{2} + \frac{a-b}{2}\right) - \sin\left(\frac{a+b}{2} - \frac{a-b}{2}\right)$
$= 2\cos\frac{a+b}{2} \sin\frac{a-b}{2}$

or $\sin a - \sin b = 2\cos\frac{a+b}{2}\sin\frac{a-b}{2}$
Form. D,
in which a is $>$ b.

123. If b is $>$ a, $\sin\frac{a-b}{2}$ is negative, and we must affix the negative sign.

124. Similarly, adding Formulas 12 and 15, we get
$\cos(x+y) + \cos(x-y) = 2\cos x \cos y$,
or $\cos x \cos y = \frac{1}{2}[\cos(x+y) + \cos(x-y)]$
Form. E,

125. Again writing for x $\frac{a+b}{2}$, and for y $\frac{a-b}{2}$,
we get $\cos a + \cos b = 2\cos\frac{a+b}{2}\cos\frac{a-b}{2}$
Form. F,

126. Lastly, subtracting Form. 12 from Form. 15, we get $\cos(x-y) - \cos(x+y) = 2\sin x\, 2\sin y$,
or $\sin x \sin y = \frac{1}{2}[\cos(x-y) - \cos(x+y)]$
Form. G,
in which x is $> y$.

127. Again writing $\frac{a+b}{2}$ for x and $\frac{a-b}{2}$ for y,
we get
$\cos\left(\frac{a+b}{2} - \frac{a-b}{2}\right) - \cos\left(\frac{a+b}{2} + \frac{a-b}{2}\right)$
$= 2\sin a \sin b$,
or $\cos b - \cos a = 2\sin a \sin b$,
Form. H,
in which a is $>$ b.

128. We must remember that the cosine of an angle nearer 90° is less than that of a smaller angle, hence the relation of cos b and cos a in the Formula. If b is $>$ a, the product 2 sin a sin b is negative.

129. These Formulas are so important that exercises on them will be contained in several of the ensuing sets of examples, and a geometrical proof given in the next chapter.

130. If A, B, and C are the angles of a triangle, or in other words, if $A + B + C = 180°$, we get many interesting relations between the goniometrical ratios of these angles, separately and connected together, *e.g.*
If $A + B + C = 180°$,
Prove $\sin A + \sin B + \sin C$
$= 4\cos\frac{A}{2}, \cos\frac{B}{2}, \cos\frac{C}{2}$.
$\sin A + \sin B = 2\sin\frac{A+B}{2}, \cos\frac{A-B}{2}$
Form. B.

$\sin C = \sin(A+B) = 2\sin\frac{A+B}{2}, \cos\frac{A+B}{2}$
Forms. 17 & 6.

$\therefore \sin A + \sin B + \sin C$
$= 2\sin\frac{A+B}{2}\left\{\cos\frac{A-B}{2} + \cos\frac{A+B}{2}\right\}$
$= 2\sin\frac{A+B}{2}.2\cos\frac{A}{2}.\cos\frac{B}{2}$. Form. F.

Since $A + B + C = 180°$; $\frac{A}{2} + \frac{B}{2} + \frac{C}{2} = 90°$
$\therefore \frac{A+B}{2} = \left(90° - \frac{C}{2}\right)$
$\therefore \sin\frac{A+B}{2} = \sin\left(90° - \frac{C}{2}\right) = \cos\frac{C}{2}$
$\therefore$ substituting this value of $\sin\frac{A+B}{2}$
$\sin A + \sin B + \sin C = 4\cos\frac{C}{2}, \cos\frac{A}{2}, \cos\frac{B}{2}$
as above.

131. We will solve an equation, which could scarcely be solved were it not for one of these Formulas.
$\sin 9x + \sin 5x + 2\sin^2 x = 1$.
$\sin 9x + \sin 5x = 1 - 2\sin^2 x$
$2\sin 7x \cos 2x = \cos 2x$. Forms. B. & 10.
$\cos 2x (2\sin 7x - 1) = 0$.
$\therefore \cos 2x = 0$, or $2x = 90°, 270°, 450°$, &c.
or $\sin 7x = \frac{1}{2}$, or $7x = 30°, 150°, 390°$, &c.

132. EXAMINATION AND EXAMPLES, VIII.

1. Prove $\sin A + \sin B + \sin(A+B)$
$= 4\sin\frac{A+B}{2}, \cos\frac{A}{2}, \cos\frac{B}{2}$.

2. Prove $\cos A + \cos B + \sin(A+B)$.
$2\cos\frac{A+B}{2}\left(\cos\frac{A-B}{2} + \sin\frac{A+B}{2}\right)$

3. Prove $\sin^3 2x - \sin^3 x = \sin x . \sin 3x$.

4. $\sin(x-y) + \sin(y-z) + \sin(z-x)$
$= -4\sin\frac{x-y}{2}, \sin\frac{y-z}{2}. \sin\frac{z-x}{2}$,

5. Solve the equation
$\sin 5x \cos 3x = \sin 9x \cos 7x$.

6. Prove $\frac{\sin 5x - \sin 3x}{\cos 3x - \cos 5x} = \cot 4x$.

7. Prove $\cos^2 2x - \cos^2 3x = \sin x, \sin 5x$.

8. Prove $\frac{\sin x + \sin(x+y) + \sin(x+2y)}{\cos x + \cos(x+y) + \cos(x+2y)} = \tan(x+y)$

9. Prove $\frac{\tan 3x}{\tan x} = \frac{2\cos 2x + 1}{2\cos 2x - 1}$

10. Prove $\left(\frac{3\sin x - \sin 3x}{3\cos x + \cos 3x}\right)^2 = \left(\frac{\sec 2x - 1}{\sec 2x + 1}\right)^2$

11. Prove $\tan x + 2\sin^2 x$, $\cot 2x = \sin 2x$.
If $A + B + C = 180°$.
Prove the following two identities.

12. $\tan A + \tan B + \tan C = -\tan(A+B)\tan A \tan B$.

13. $\cos A + \cos B + \cos C = 4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2} + 1$.

14. If A, B, C are the three angles of a triangle, and a, b, c the sides opposite to them, remembering Ex. III., 6.
Prove $\frac{a-b}{a+b} = \frac{\tan\frac{A-B}{2}}{\tan\frac{A+B}{2}}$

15. Hence prove $\frac{a-b}{a+b}\cot\frac{C}{2} = \tan\frac{A-B}{2}$

16. Prove $\frac{\cos 3A - 2\cos A}{\sin 3A + 2\sin A}\tan A = -\frac{4\sin^2 A + 1}{4\cos^2 A + 1}$

17. Prove $\frac{2\cos 2A - 3}{2\cos 2A + 3} = -\frac{4\sin^2 A + 1}{4\cos^2 A + 1}$

18. If $a\cos\phi = b\cos\theta$.
Prove $\frac{a+b}{a-b} = \cot\frac{\theta+\phi}{2} - \cot\frac{\phi-\theta}{2}$.

19. Prove $\sin\theta + \sin 2\theta + \sin 3\theta = 4\cos\frac{\theta}{2}, \cos\theta, \sin\frac{3\theta}{2}$

20. Resolve $8\sin^3\frac{\phi}{2}\cos^3\frac{\theta}{2}$ into 4 terms.

21. Prove $\sin 2A, \sin A = \cos A - \cos A, \cos 2A$.

22. Prove $\frac{\cot A}{\cot A - \cot 3A} = \frac{\cos A, \sin 3A}{\sin 2A}$.

23. Prove $\frac{\tan A}{\tan A - \tan 3A} = -\frac{\cos 3A, \sin A}{\sin 2A}$

24. Hence from 22 and 23 prove:
$\frac{\cot A}{\cot A - \cos 3A} + \frac{\tan A}{\tan A - \tan 3A} = 1.$

25. Prove $\frac{\sin(a+b) + \sin(a-b)}{\cos(a+b) - \cos(a-b)} = -\cot b.$

(To be continued.)

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How to teach the Babies.

BY JAMES BAILEY.

Head Master of the Southlands Training College.

CHAPTER II.

THE SCHOOL AND ITS FITTINGS.

The School.—It may be well, at the outset, to ascertain what kind of school, or schools, for the Babies, at present exist. Our former paper showed something of what kind of person a 'School-baby' is, and what are his physical and mental characteristics and requirements. How far do existing schools and their appliances meet those requirements? From no better source can we obtain an answer to this question than in what H.M. Inspectors say of infant schools in their reports to the Education Department. And we need search no further than in those published in the last Blue Book. Mr. Alderson quotes from the report of Mr. Burrows for 1882, who, he says, draws a graphic picture of the infant class as it is too often to be found 'in the hands of a dull monitor, frequently packed away in a dark corner of the main room, or in a dingy class-room, where the luckless little creatures have only the opportunity of learning how, without crying, to sit still for hours with dangling legs and aching backs.' Again, Mr. Codd says, 'the chief defects in the accommodation are the want of playgrounds and class-rooms.'

Mr. Fisher, 'It is short-sighted thrift that stints an infant school of what is needful to make it healthy, comfortable, cheerful and attractive. Too rarely do we find the rooms tidy, cleanly, well lighted, sensibly ventilated, and supplied with seats which allow heels to rest. Too rarely do we find flat tables on which the little ones may lay sticks, build with bricks, draw figures, plan rooms, and so on.' Similar testimony is borne by Mr. Dewse.

Having looked on that picture, let us now look on this. Mr. Legard says, 'A great improvement has taken place in the infant schools.' Mr. Codd, 'The educational appliances in use in the schools have distinctly improved since the coming into force of the New Code; and this is more particularly noticeable in the infant classes.'

The testimony on this point borne by Mr. Fitch, one of the ablest and most experienced of H.M. Inspectors, is very emphatic, 'There is no department of educational work in which the recent improvement is more striking than the infant schools.' 'The London School Board has taken special pains to secure the services of highly skilled and experienced infant teachers, and to equip the school-rooms with all needful appliances.' 'The district of East Lambeth is exceptionally fortunate in possessing a considerable number of the brightest, happiest, and most efficient infant schools I have ever seen in this, or in any other country.' And the testimony of Mr. Synge points in the same direction, 'The younger children have, I think, received most benefit from the changes in the Code. Efforts have been made, not only in the infant schools, but also in the infant classes of country schools, to make the school life of the little children less monotonous than it used to be. The really good infant schools have become very satisfactory places of education, and free from any of the defects with which the schools for older children may still be charged.' These extracts make it clear that there exist among us two extreme types of infant school arrangements; the one extremely bad, the other extremely good, with, doubtless, every grade of difference between these two extremes. Here we see something of what to avoid, and something of what to aim at in respect of infant school accommodation and provision. What is wrong is not yet wholly extinct. What is right is shown to be practicable, and is, to a considerable extent, provided.

A being so susceptible to external influences as is a little child, necessarily requires a fitting place in which to develope his bodily and mental faculties. It is consequently a matter of great importance to provide a suitable room and fittings, so as to satisfy the physical conditions of child life. And first as to *size*. School-room and class-rooms should have ample air-space and floor-space. The reasonable minimum requirement of the Code for all schools is that of at least 80 cubic feet of contents and 8 square feet of area for every child in average attendance. Less than this will not suffice for the due keeping up of health and energy. A little child, like a tender plant, droops even more quickly than older children, because it has far less resisting power to oppose to adverse influences. There should be an ample amount of *air*. Then, too, as to *area*, plenty of *free floor space* is needed, on which to give marching, playful exercises, suitable games, and other occupations necessary to the full development of limb and lung. Here it may be remarked that the lack of this is a faulty arrangement marring some of the noble buildings which have been erected in recent years by the School Boards for London and some large provincial towns. Large lofty rooms have been provided, in some cases of such a shape, or so crowded with furniture, as to leave insufficient space for the marching and other exercises so natural and healthful, which characterised the best infant schools of even an earlier date. Sometimes

a square-shaped infant class-room, quite large enough for the class it accommodates, has its raised gallery built along the entire length of one side of the room. Four rows of seats give a place for each child, but it has so inconveniently wide a front, that the teacher has no easy command of all with eye and voice. To meet this difficulty the gallery of another similar class-room is made deeper, say with six rows of seats, and shortened proportionately. Placed in one corner of the room, it reaches from one side partly towards the other, forming a recess at the side, of small value, and leaving in front too little space for the required purposes.

Still worse is it when the room is crowded with the dual desks in which the little children, though comfortable enough when seated, are yet imprisoned during the whole time they are in the room. Some relief is no doubt afforded by the 'desk drill,' excellent in its way, but insufficient in variety, and in play of free muscular movement.

The Ventilation.—Of at least equal importance to the size and arrangement of the room is its provision for *Ventilation*, so as to ensure a due supply of fresh air. Air quickly grows impure by being breathed. Languor, lassitude, and worse consequences result from breathing in a close and vitiated atmosphere. Hence the need of providing for the constant discharge of impure air, and the constant ingress of pure air. The teacher can rarely influence the structural arrangements by which this may be secured. But whatever expedients are devised, it is the teacher's duty to see that they are rightly employed. On the whole, the windows supply the simplest, most natural, and most effectively applied means of school room ventilation. The wonder is as common as it is reasonable that all the resources of modern skill and appliances so usually fail to secure the thorough and sufficient ventilation of a room, without exposing its inmates to the risk of mischief caused by draughts, Little children are scarcely conscious of the danger; they can hardly complain of the discomfort; they can do little more than endure and suffer. Therefore in this as in other allied matters, they must be protected by the watchful care of the teacher. It should be borne in mind that regard to ventilation is not less necessary in winter than in summer. The windows should be opened several times during the day, for a few minutes at least, and especially should a thorough change of air be obtained by keeping them open during the play time recess. The practice, not too rare, alas! of sending the children *only* out into the playground, and of the teachers sitting round the fire in cold weather, with closed doors and windows, or at any time, otherwise occupied in the school room, is greatly to be deprecated.

The Temperature.—Closely connected with the ventilation of the room is that of its *Temperature*. This should be regulated, not by the feelings of the teacher, which are frequently an unsafe guide, but by the thermometer. Every schoolroom should be provided with one, and the temperature should be kept as nearly as possible at 60° F. The best way of warming a schoolroom is by an open fire, except for very large schools, when hot water apparatus or something similar will be required. The open fire promotes cheerfulness, aids greatly in ventilation, and is, on the whole, the most comfortable source of warmth. But it must be carefully guarded: no children should be allowed to sit very near it for any length of time, and it should be placed where it may most equally diffuse the warmth throughout the room.

The Light.—Every schoolroom should be well *lighted*, which implies that the light should be sufficient, fall in the right direction, and be well diffused. It is astonishing to see the mistakes often made as to the amount and position of window space, as, indeed, is similarly the case with the position of doors and fireplace. It is well that the windows should be as high in the wall as possible, and the children should be so placed that the light shall fall neither wholly upon their faces nor their backs. Side lights are the best, that from the left being preferable. Further, every window admitting direct sunlight should be shaded by blinds, so as to avoid the distress, and the injury to the sight accruing from exposure to excessive glare.

The Playground.—In addition to the necessary offices, a lavatory, and water supply, every school, the Infant school pre-eminently, should have a playground (part of which should be covered) or, as Mr. Stow so wisely termed it, an *uncovered schoolroom*. He held it of equal, if not superior, value as a place and means of moral training, to that of a mere recreation ground. For either purpose it needs the careful supervision and sympathetic presence of the teacher. For *Babies*, especially, its happy companionship, and kindly oversight, forms an educational appliance of a very high order.

The Fittings. (1) *The Furniture. The gallery* should be large enough to hold all the class at once; its risers of four or five inches, its seats low and well backed. It is a sad sight to see little children on an ill-constructed gallery; steps and seats too high, no support for back or foot, even, as may sometimes be seen, with no protection at the side from falling over. And it is little short of cruelty to subject them to its discomfort. *Desks* are convenient, when suitably made, for occasional, but not for constant, use. They must be rightly proportioned to the requirements of their small occupants in height, width, and relative position of the seats, and flat rather than sloping. *Forms*, similarly suited, will also be wanted. (2) *Apparatus.* The chief items are a blackboard, which, when large enough and when the position of the class with relation to it admits of it, may be fixed with advantage to the wall, either vertical, or with a slight slope; some good specimens of common objects; the simpler forms of kinder garten apparatus, a ball frame, coloured *beads*, bits of *cloth* and *ribbon*, pieces of coloured *glass* (for the teacher's use), simple geometrical *forms*, large and well-printed *reading cards*, and above all a good supply of pictures illustrative of *natural history, objects, trades, natural phenomena*, &c.

The Arrangements of the School. It is very instructive to note the diverse impression made upon the mind by the different appearance presented in one school from that of another similar in general appointments. The disposition of the furniture, the pictures, the scholars; the presence or the absence of small but significant tokens of the teacher's interest and taste; help much to make up the 'tone' of the school which gives it *individuality*, and which produces on the mind of an observant spectator a vastly different idea of the educative training afforded to

the scholars of the respective schools. When we consider the influence of a child's 'environment' upon his progress, still more upon his future character, we shall recognise the importance of doing all we can to make the schoolroom attractive, cheerful, and tasteful. First, the room should be kept scrupulously *clean*. The floor should be swept and dusted daily, and thoroughly scrubbed at intervals. It should be kept free from litter, whether of paper, clothes, or anything else. The walls, and ceilings too, should be swept and cleaned two or three times a year, the windows more frequently, and there should be no accumulation of cobwebs or dust allowed in any part of the building. The furniture and apparatus should be tidily arranged; neatness and order should characterise every part of the school arrangement. Pictures and maps should be hung with some regard to good taste. A few growing plants in the window-sills, and at least an occasional supply of flowers, with a few simple ornaments for the decoration of the room, will do much to make it attractive and pleasing to the children, and to foster in them a love of cleanliness, order, and taste, which may have its effect in brightening the home and elevating the future life. The children themselves should be trained also to abstain from injury to the furniture, from defacing the walls, and to a careful regard for everything around them. An extract from Mr. Fitch's admirable 'Lectures on Teaching' will fitly close this paper in better words than any I could myself employ. 'Every time you enlist the services of the scholars in some little effort to render the schoolroom and its surroundings more comely and attractive, you are doing something to encourage the feeling of loyalty and pride in the school, and are doing still more to educate them into a perception of beauty, and a desire for refined and tasteful surroundings. In schools for the poor this aim is especially important; but in schools for children of every rank it must be borne in mind that the careful and artistic arrangement of all the school material and of all pictures and illustrations, is a silent but very effective lesson in good taste, and will go far to make children love order and neatness. Whoever carries into his own home a feeling of discomfort and of æsthetic rebellion against dirt, vulgarity and untidiness, has learned a lesson which is of considerable value as a foundation for an orderly life.'

(To be continued.)

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Animal Physiology.

BY ARTHUR NEWSHOLME, M.D., AND C.S.S. (LOND.)

MECHANICS OF RESPIRATION.

THE elastic structure of the lungs is in the living animal constantly to some extent on the stretch. During inspiration the dilatation of the chest walls increases this stretching; during expiration it is somewhat diminished; but complete elastic recoil and consequent collapse of the lungs never occurs unless the pleuræ are opened to the atmosphere (as by a wound or from disease).

The Thorax. A study of the thorax will enable one to understand the mechanism by which the lungs are alternately stretched and then partially recoil. The walls of the thorax are formed by the dorsal vertebræ behind, the curved ribs laterally, and the sternum and costal cartilages in front. The curve of the ribs downwards and forwards, and the size of the curve made by them, increases from the first to the ninth or tenth rib. The only joint at which each rib can move freely is the one by which it is attached to the corresponding vertebra. This is the pivot on which the movements of the ribs occur, and a moment's consideration will shew that if a rib is pulled up by muscles attached above it the resulting movement must necessarily be an oblique one. The rib will be everted at the same time as it is raised; and anteriorly, owing to the attachment of the costal cartilages to the ribs and to the sternum, the sternum will be thrown forward. In this way both the lateral and the antero-posterior diameters of the chest are increased.

The upper end of the thorax (corresponding to the truncated apex of a cone) serves for the entrance into the thorax of the trachea, the great blood-vessels of the neck, and the gullet. The lower and basic end of the thorax is separated from the abdomen by the diaphragm.

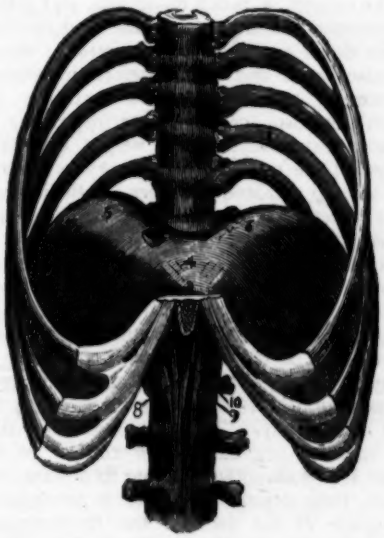


Fig. 48.

The thorax, from which the upper ribs have been removed in order to shew the diaphragm.
vi. to x., 6th to 10th ribs. 1—7, diaphragm.
8—10, pillars of diaphragm.

The Diaphragm. This large and important muscle is fixed to the inner wall of the lower end of the thorax. In front it is attached to the lowest point of the thorax, laterally to the inner surface of the six lower ribs; and posteriorly it is fixed by two wide tendinous bands to the bodies of the lumbar vertebræ. Within this circumference it mounts into the cavity of the thorax, forming a vaulted arch, on the upper convexity of which rest the lungs and heart, while the liver, stomach, and spleen fit into the lower concavity. The central part of the diaphragm is tendinous, the tendon being shaped

somewhat like a trefoil leaf; the rest of its substance (except the tendinous attachment to the vertebræ) is muscular. Three openings through the diaphragm allow the œsophagus, aorta, and inferior vena cava to pass through it.

Intercostal Muscles. The space between the ribs and costal cartilages is filled by two sets of muscles; the external intercostal muscles lie between the ribs, and run obliquely from above downwards and forwards; the internal intercostals come further forward and have a direction nearly at right angles to the others.

Ordinary Inspiration. Ordinary inspiration is effected by descent of the diaphragm and elevation of the ribs; and expiration by reversal of these movements. Elevation of the ribs is secured by the action of the intercostal and other muscles. It is probable that certain muscles (called Scalenus anticus and medius), which reach from the sides of the cervical vertebræ and are attached below to the first and second ribs, first of all raise and fix these ribs, and thus make them a fixed point of action for the lower intercostal muscles.

The external intercostal muscles produce elevation and eversion of the ribs by their contraction, and make them more nearly horizontal than before.

The action of the internal intercostal muscles has been the subject of much discussion, and great differences of opinion still exist. Some hold that they pull the ribs down and are thus expiratory: others that they raise them and are therefore inspiratory like the external muscles: others that the portions between the costal cartilages are inspiratory and the remainder expiratory. The weight of evidence is in favour of the view that assuming the first rib to be fixed by the scalene muscles, both internal and external intercostal muscles help to raise and evert the ribs.

Descent of the diaphragm is produced by its contraction. Muscular contraction means shortening of the muscular fibres, and only by descent and consequent flattening of the diaphragm can this shortening be effected. The diaphragm does not become entirely flat during its contraction, and the tendinous part, to the upper surface of which the pericardium is fixed, moves little if any. The diaphragm and the intercostal muscles are under the control of different nerves. If the diaphragm, owing to disease, ceases to contract, then raising of the ribs is accompanied by an increase of the arch of the diaphragm. This would evidently be the tendency, the abdominal viscera being drawn up into the arch to fill the partial vacuum produced by expansion of the chest walls. Thus the simultaneous effect of the action of the intercostal muscles—in increasing the antero-posterior and lateral diameters of the thorax,—and of the diaphragm—in increasing the vertical diameter of the chest—produces a much greater aspiration of air through the trachea than either alone.

As the diaphragm is depressed, it necessarily pushes the abdominal viscera before it, and inspiration is therefore accompanied by protrusion of the abdomen. A forced or deep inspiration renders this very obvious.

Sudden and spasmodic contraction of the diaphragm (involving sudden entry of air through a glottis which is unprepared and therefore closed and in the position for producing vocal sounds) leads to curious and familiar phenomena. Hiccough and sobbing are caused by such spasmodic contraction of the diaphragm; the former due to reflex action from an irritated stomach, and the latter to some extent voluntary.

Extraordinary Inspiration. Ordinary inspiration is produced chiefly by the muscles already described. In hard breathing other muscles are called into play. Any muscle fixed to the head, or neck, or shoulders, or arms, at one end, and to the ribs at the other, would, assuming the former to be the fixed point raise the ribs and thus help inspiration, though as a rule in the action of these muscles the ribs form the fixed point. Such muscles are the Sterno-Mastoid and the Pectoral muscles. These can be seen to stand out prominently when there is any chronic difficulty of breathing.

Types of Respiration. In children under the age of three years, the most marked action in inspiration is that of the diaphragm, and the consequent up and down movements of the abdomen are very prominent.

In men the lower ribs are chiefly moved, along with the diaphragm. In women the action of the muscles expanding the chest above the seventh rib is much more prominent. The superior costal type of respiration in women seems to be universal and not due to tight lacing; though there can be no doubt that constriction of the lower part of the thorax greatly increases the necessity for this form of respiration, and would tend in a few generations to establish it, if it did not naturally exist.

Atmospheric Pressure and Respiration. We have described the mechanism by which expansion of the chest walls and fall of its floor are produced. We have also seen that the two pleuræ securely connect the outer surface of the lungs to the inner surface of the chest walls and the upper surface of the diaphragm. The atmosphere according to the general law causes a pressure of 15 lbs. on every square inch of the surface of the chest. The tendency of this is to cause the collapse of the lungs from their stretched condition. Were it not for the ribs, this pressure would have its natural effect. On the internal surface of the lungs there are however no such rigid rods to prevent the atmospheric pressure exerting its due force. Consequently the air in the interior of the lungs (being continuous through the trachea with that outside) exerts a pressure on the lungs of somewhere near 15 lbs. per square inch. When the chest walls are enlarged in inspiration, this atmospheric pressure forces the lungs to expand and follow the movements of the chest walls. Thus the lungs follow every movement of the chest walls.

If the equilibrium of atmospheric pressure between the outside and inside of the lungs is restored, then the elasticity of the lungs comes into play and they collapse. Thus in a dead rabbit, if the abdomen be opened and the diaphragm viewed from below, the lungs can be seen closely in contact with the diaphragm. If the diaphragm be pinched with a pair of forceps and pulled down, the lungs will follow it. If now the right half of the diaphragm be pricked, air rushes into the corresponding pleural cavity and the right lung at once collapses. If next a small opening be made between two ribs on the left side and the left lung watched through the translucent diaphragm, it will be seen to collapse.

(To be continued.)

HOMEWARD BOUND.

Allegretto.

mf

1st TREBLE.
2nd TREBLE.
BASS.

1. The day - beam in the crim - son west, Now smiles a - dieu o'er hill and dell; The
2. How light the touch of ze - phyr's wing, Per - fum'd with ev' - ning's dew - y flow'rs; As

KEY B♭. *Allegretto.*

mf

1st TREBLE. | s, :— :d | d :— :d | r :— :m | f :— :r | m :— :s | d :t, :d | t, :— :r | s, :— :f |
2nd TREBLE. | m, :— :m, | m, :— :m, | s, :— :s, | f, :— :s, | s, :— :s, | fe, :— :fe, | s, :— :fe, | s, :— :s, |
BASS. | d, :— :d, | d, :— :d | t, :— :d | l, :— :t, | d, :— :t, | l, :— :r, | s, :— :l, | t, :— :t, |

bird has found its leaf - y nest, And na - ture sings her ves - per bell.
if their balm - y breath would fling, New beau - ty o'er those part - ing hours.

m :— :d	r :— :m	d :— :m	r :— :d	F.t. t,m :— :s	l :— :f	m :— :r	d :—
s, :— :s,	t, :— :t,	l, :— :t,	l, :— :fe,	s,d :— :d	d :— :d	d :— :t,	d :—
d, :— :m,	s, :— :se,	l, :— :s,	fe, :— :r,	s,d :— :m	f :— :l,	s, :— :s,	d :—

p

One look while ling - 'ring on the shore, A fond fare-well to all a - round; Then
This day will live when forms grow old, And brows with win - ter frost are crown'd; And

f.B. *p*

:d s,	s, :— :s,	s, :— :s,	s, :— :s,	s, :— :s,	m :— :r	d :— :f	d :— :t,	l, :— :s,
:l m,	r, :— :m,	f, :— :m,	r, :m, :f,	m, :— :m,	s, :— :se,	l, :— :l,	l, :— :se,	l, :— :r,
:f d	t, :— :d	r :— :d	t, :d :r	d :— :d	d :— :t,	l, :— :r,	m, :— :m,	l, :— :t,

gai - ly on the deep once more, We're home - ward bound, we're home - ward bound.
hearts will leap with joy un - told, When mem - 'ry whis - pers home - ward bound

s, :— :s	m :— :d	r :m :f	m :— :m	s :— :m	s :f :m	r :— :s	d :—
m, :— :m,	s, :— :s,	t, :d :r	d :— :d	m :— :d	m :r :d	t, :— :s,	m, :—
d :— :d	d :— :m,	s, :— :s,	d, :— :d,	d, :— :d,	d, :t, :d,	s, :— :s,	d :—

How I Teach Domestic Economy.

BY MRS. WIGLEY,

Author of 'Marshfield Maidens,' 'Our Home Work,' 'Workers at Home,' 'Royal Series Domestic Economy,' 'Cookery and Home Comforts,' 'The Merryweathers,' 'Thoughts,' etc.

CHAPTER XVIII.

VEGETABLES AND THEIR CONSTITUENTS.

WE are quite safe in saying that our vegetable foods are not half enough appreciated and understood, even in these days of enlightenment. We have grown up in the belief that 'meat' is all that is good and excellent, and that vegetables at the best are only an appendage, and by no means a substitute, sufficient for it, that we must confess to a sense of something akin to a hardship when we have no meat for dinner.

There is no doubt in our minds really that this is only a prejudice, but we are not sufficiently *stirred up* in the matter to bring our knowledge to bear upon our daily practice, and only too many of us go on in the footsteps of our fathers in spite of all our very superior knowledge and information.

There is no excellent quality in flesh but we can find its equivalent in vegetables, and if only we would try it our tables might produce a more dainty, enjoyable, and less expensive bill of fare without our altogether becoming vegetarians.

Which of us, for instance, really find 'our mouths water' over the words 'vegetable soup,' and yet how delicate and delightful a thing this may be made.

How many dishes which are in such high favour with our French neighbours are really composed of vegetables and nothing else. And they are light, nourishing, and enjoyable.

I don't think that this subject has always been presented in the best way to our children's minds. It is always likely to provoke antagonism if we advocate one kind of living for the rich and another for the poor. The actual need of the body is alike in all cases; and all which has to supply that need should be of the best possible quality, and prepared in the daintiest, nicest way.

I happen to have by me now a little book published in 1863. Its title-page says that it contains 'useful hints intended for girls' day schools.' It is all in rhyme, and I am going to copy a recipe for a vegetable soup, which does *not* read very inviting, to say the least of it.

VEGETABLE SOUP.

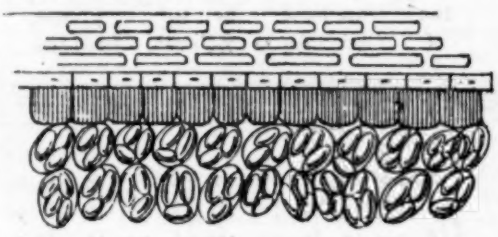
'The heart of a cabbage or sprouts,
With turnips and carrots cut small,
Boil them well for more than an hour,
Adding pepper and salt and all.
Slice and fry some onions thin,
And when the broth's done quite enough,
Throw them in with some crusts of bread,
Which directly makes excellent stuff.'

With all due respect to the poet I must beg leave to differ from the opinion expressed in line number eight.

I should like to impress upon you the necessity of giving all possible importance to the value of vegetables in your lessons on this part of the subject. You cannot estimate the good you will be doing if you can show them the most inexpensive way of procuring comforts, and if our busy little maids are once enabled to consider the need and then seek the supply, all for whom they may have to cater will be the better for it.

The vegetable foods are so numerous that we can do no more than consider some of them. It will simplify our work if we divide them into classes: grain foods, green foods, root or tuber foods, and fruit foods. Let us take first, *Facts to be remembered about grain foods.*

The principal grain-bearing plants are wheat, barley, oats, rice and rye. The plants themselves are all grass-like, and the grain is the fruit of such plants with its coverings. 'All the middle part of the grain is occupied by large, thin cells, full of a powdery substance, which is nearly white and opaque in soft wheats. This part contains much starch, in fact, nearly all the starch of the grain. Outside the central starchy mass is a single row of squarish cells filled with a yellowish material, very rich in nitrogenous—that is, flesh-forming—matter. Beyond this again there are six thin coverings or coats, containing much mineral matter. This mineral matter contains both phosphates and potash. The outer coat of all is of the least value as a food substance.



Magnified Section of a Grain of Wheat.

Now it stands to reason from this description that the entire grain should be used as food. We need the starch, we need the nourishment, and we need the phosphates. If we dispense with either of these things we are losers. We love white bread, perhaps, so we take out of the flour the yellow material wherein lies the nourishment, and the outer coats which contain the minerals, but in doing so we rob ourselves of valuable food.

'For one part of flesh-formers in fine wheaten flour, there are 7¼ parts of heat-givers, reckoned as starch; while for one part of flesh-formers in bran there are not quite four parts of heat-givers reckoned as starch.

'One pound of wheaten flour cannot produce more than about 1⅝ oz. of the dry nitrogenous substance of muscle or flesh, but one pound of bran contains more than 2½ oz. of the same constituents.'—*Professor Church.*

Comparative nutritive value of the grain plants:—

	Wheat	Oatmeal	Barley	Rice	Maize	Rye
	oz. grs.	oz. grs.	oz. grs.	oz. grs.	oz. grs.	oz. grs.
Water	2 35	0 350	2 147	2 147	2 140	2 35
Fibrine, etc.	1 297	2 252	0 434	1 87	1 193	1 298
Starch, etc.	11 368	10 252	12 70	12 70	10 140	11 157
Fat	0 57	1 269	0 91	0 35	0 350	0 66
Cellulose	0 49	0 259	3 56	0 63	0 350	0 161
Mineral matter	0 49	0 147	0 77	0 35	0 140	0 112

Facts to be remembered about Green Vegetables.—Green vegetables contain very little nitrogenous or warmth-giving foods. They are principally valuable because they are rich in saline, or mineral matter.

We use cabbage, Scotch kale, Brussels sprouts, savoys, red cabbage, cauliflower, and broccoli. Cabbage contains a greater proportion of warmth-giving, but not so much nitrogenous matter as cauliflower. Besides these green foods, we also use spinach, and swede and turnip-tops. Young nettle-tops are almost equal to spinach when properly dressed. Sea kale is succulent, and delicate in flavour; it contains both nitrogenous and warmth-giving foods.

We do not enough value or make use of our salad plants, as lettuce, endive, cress, radish, beetroot, etc. The cooking of green vegetables removes the potash, which salad plants retain, and which does good work in purifying the blood.

Great care should be taken to properly cleanse salad, or we may take uncooked *animal*, as well as vegetable food, from the bowl.

The best way of cleansing salad is to have two bowls of water, one containing hot water, the other cold water and salt. After trimming the vegetable, give it one quick dip into the hot water; then at once drop it into the cold, and let it remain a second or two. If properly managed, this treatment causes all insects to float off the leaves into the water. There should be a plentiful rinsing in fresh water at the last.

Comparative nutritive value of green foods:—

	Cabbage		Seakale		Vegetable Marrow		Lettuce		Celery		Water-cresses	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water	14	105	14	406	13	73	15	157	14	406	14	392
Albumen	0	105	0	168	0	42	0	49	0	84	0	119
Sugar, starch, or gum	0	406	0	196	0	182	0	112	0	266	0	189
Fat	0	35	0	0	0	14	0	14	0	0	0	35
Cellulose	0	140	0	63	0	91	0	35	0	63	0	49
Mineral matter	0	84	0	42	0	35	0	70	0	56	0	91

Facts to be remembered about Roots and Tubers.—We should direct our children's attention to the large proportion of water which some of our vegetable foods contain. In the summer time, when green foods are most plentiful, they are most refreshing and grateful to us. It is not a bad thing that so many of our foods contain so much water; only we must learn to estimate it as *water*, and not as either nitrogenous, carbonaceous, or mineral food.

Potatoes form our most important vegetable food next to the cereals, and one of our greatest calamities in garden culture has been the potatoe disease. It is difficult to account for this, as so many opinions exist concerning it. A large potato-grower, in writing to the *Times*, expressed the belief that it was caused by not planting *the seed* instead of the bulb. The seed is the potato apple. The theory that it is caused by too much moisture seems to be proved by the disease spreading most in wet seasons. We make use of potatoes in many ways. The starch obtainable from them is sold as arrowroot. Professor Church says—'Large quantities of British brandy are made from potato starch.'

Comparative nutritive value of roots and tubers:—

	Potato		Turnip		Carrot		Parsnip		Beet-root		Arti-choke		Onion	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water	12	0	14	371	14	105	12	420	13	67	12	350	14	245
Albumenoids	0	16	0	35	0	35	0	84	0	28	0	140	0	105
Starch, sugar, or gum	2	350	0	210	0	350	1	130	1	490	2	133	0	336
Fat	0	21	0	7	0	14	0	105	0	7	0	35	0	14
Cellulose	0	70	0	126	0	301	0	392	0	210	0	140	0	140
Mineral matter	0	70	0	56	0	70	0	70	0	63	0	77	0	35

Facts to be remembered about Fruits.—We cannot pretend that our home-grown fruits are in favour because they furnish us with any very important nutrients. Like salad plants, they are agreeable, pleasant, and refreshing, and contain certain saline properties which are beneficial to the blood. But we cannot help noticing how wonderful is the provision made for the wants of the natives of hot climates. There they could not partake of the heavier kinds of food, and the juicy fruit is received gratefully and much enjoyed. In such regions we find the fruits rich in those properties required for necessary diet.

I remember reading a lament from a mother of a family a few years back to this effect. She said that when the family health fell below par, and they were all in a lack-energy, grumbling, ailing condition, it was their custom to migrate to the south of France, or some such-like locality, and stay for a month or so; that while at home no amount of nourishment, or codling, or doctoring, produced any extra strength, yet in those regions all subsisted, yea, improved and gained health and strength, upon a few dry biscuits and a bunch of grapes; that a thought or reminder of butchers' meat created a nausea, and the mention of beef-tea provoked a smile.

Also I have read that Sir Henry Thompson has said that instead of taking a glass of sherry or port when he is very much overdone, he takes *a few grapes*, or, these failing him, *a few raisins*, and the fruit answers the good end of the stimulant without effecting its evil results. This is worth remembering. You have only to feel 'literally done-up,' and to moisten your mouth with a muscatel or two—between lessons, if you need it—and you will find out there is something more than water and potash in foreign fruits, at least.

And we must remember also that the regular use of our own fruits is highly beneficial in other ways than as nourishment. A medical man once said, 'If every one would eat either an orange or an apple before breakfast every day, the physicians and druggists would have to change their profession; people would manage very well with surgeons only.'

Fruits may be divided into two classes—(1) the saccharine and (2) the oily fruits. These latter will, of course comprise the nuts.

Analysis of Home-grown Fruits:—

Constituents.	Apples		Pears		Goose-berries		Grapes		Peaches		Rhubarb	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water	13	122	13	203	13	332	12	350	13	363	15	94
Albumen	0	98	0	21	0	28	0	49	0	35	0	63
Sugar	1	39	1	52	1	52	2	35	0	126	0	147
Malic-Citric Acid	0	70	0	7	0	105	0	56	0	49	0	21
Gum, etc.	0	364	0	322	0	133	0	217	1	122	...	
Cellulose	0	224	0	259	0	189	0	140	0	238	0	77
Mineral matter	0	98	0	21	0	35	0	28	0	42	0	35

Analysis of Foreign Fruits:—

Constituents.	Figs		Dates		Bananas		Carob Beans		Mangoes	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water	2	350	3	143	11	301	2	147	0	350
Albumen	0	427	1	25	0	336	1	60	1	227
Sugar	9	88	8	280	3	66	8	126	...	
Starch	0	210	...		...		...		1	66
Gum, etc.	0	328	1	424	...		2	252	...	
Fat	0	63	0	14	0	42	0	77	11	298
Cellulose	1	83	0	385	0	14	1	10	0	210
Minerals	0	161	0	112	0	56	0	203	0	161

It will be no wonder to us that the simple Arab can subsist and be hardy and strong with no food supply but his dates. Beef contains only 1 oz. 122 grains of nitrogenous matter in a pound weight. Dates contains nearly as much.

Analysis of oily fruits or Nuts :—

Constituents.	Walnuts		Filberts		Ground nut		Pistachio nut		Cocoa nut	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water	7	53	7	297	1	87	1	80	7	200
Albumen	0	0	1	151	3	403	3	272	0	385
Oil	5	24	4	245	8	0	8	77	5	325
Mucilage, etc.	1	185	1	340	1	382	2	35	1	130
Cellulose	0	56	0	175	0	315	0	175	0	903
Mineral matter	0	119	0	105	0	196	0	321	0	70

There are other kinds of nuts besides those mentioned above, as Brazil nuts, chesnuts. The last forms the staple food among the poor in Spain, Italy, and Southern Europe. They contain a large proportion of Starch. The meal is made into cakes and boiled or roasted. We have also the common Hazel nut and the cob nut.

Nuts generally contain about 50 per cent. of oil. They are not easily digested unless ground into meal, when some of the oil is expressed and they lose part of their superabundant richness. Mixed with meal, or the lighter kinds of food, and cooked, they become pleasant and harmless. All nuts are best eaten fresh. The oil is apt to become rancid with age, and is then very unwholesome.

But our tables of constituents would be incomplete if they did not include our common beverages.

At least we must know something of the

Analysis of Tea, Coffee, and Cocoa :—

	Tea		Coffee		Cocoa	
	oz.	grs.	oz.	grs.	oz.	grs.
Water	1	122	0	259	0	350
Theine	0	175	0	42	0	0
Tannin	0	105	0	280	0	0
Albumenoids	0	0	2	175	2	315
Essential oil	0	28	0	0	2	70
Extractives	2	175	5	280	0	210
Cellulose, etc.	0	0	6	63	1	122
Mineral matter	0	399	0	322	0	252
Insoluble matter	8	308	0	0	0	0

Now, I have no doubt the question will occur to your minds—'What are we to do with all these tables of constituents? Are we expected to teach them to our children?' There is no doubt that if the matter could be made sufficiently interesting to them, it would be a very good thing that they should have such condensed, pithy statements at their 'finger ends.' But we cannot hope to accomplish an end so desirable for the ready grasping of our subjects. The little minds cannot grasp so much that is to them merely statistical. At the best we can do no more than lead them to associate the nutritive value of any food with the food itself. It will be of great value to the children if you cause them to prepare a book of tables, copying from the black board or taking down from careful dictation into a little book made for the purpose, just as many, or rather as few, tables of analysis as I have inserted in these pages. Then, when they are *getting up* any of our food products, if they refer to these tables, and if now and then, to fill in a few spare moments, you require them to make a list of the most nutritive of flesh foods, vegetable foods, fruits, and beverages, there will gradually settle into their minds a correct conviction as to their actual food value. Some of them they must learn by heart, *which* you will easily decide.

Extract for dictation respecting the foods of other nations :—

'*Indian foods.*—The Hindoos live chiefly upon grain and fruits. Here is a list of their common foods: pulse—salep—arrowroot—fungi—oils—sugar—spices—root condiments—and narcotics, such as opium.

'*The Chinese* take wines and spirits—oils—confectionery, preserved fruit and vegetables, dried fruits and grain, bamboo shoots preserved, cinnamon and cassia buds, condiments and spices. The Chinese are clever at all kinds of preserving. Some of their fruits they preserve in brine and salt, others in treacle and sugar. Sometimes they preserve the root, at others the fruit or the flowers of the delicacy they care for. They also eat several kinds of sea-weed, birds' nests, and fish.

'*Japanese foods.*—The Japanese eat wheat, rice, and many other cereals, gelose, a gummy substance prepared from sea-weed, dried and salted fish, sea slugs and confectionery.'

Examination of Pupil Teachers.

GOVERNMENT QUESTIONS ON SATURDAY, APRIL 10, 1886, WITH ANSWERS.

END OF SECOND YEAR.

Three hours and a half allowed.

BOYS ONLY.

Euclid.

[All generally understood abbreviations and symbols for *words* may be used, but not symbols of operation, such as −, +, ×.]

(Answer two questions, including Question 3, if you can do so.)

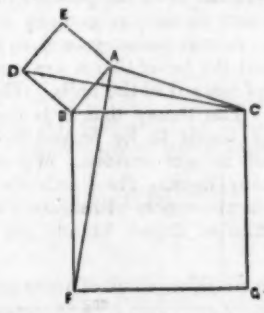
1. The angles at the base of an isosceles triangle are equal to each other, and if the equal sides be produced the angles on the other side of the base shall be equal.

Book I. Proposition 5.

2. The greater side of every triangle is opposite to the greater angle.

Book I. Proposition 18.

3. ABDE, BFGC are squares on two sides of the triangle ABC, and AF, CD are joined. Show that AF is equal to CD.



Because ABDE is a square, AB is equal to DB. (Def. 30.)
And because BFGC is a square BF is equal to BC. (Def. 30.)
Also the angle DBA is equal to the angle CBF, each of them being a right angle. (Ax. 11).
To each of these equals add the angle ABC.
Therefore the angle ABF is equal to the angle DBC. (Ax. 2).
Therefore in the triangles ABF, DBC, the sides AB, BF, and the included angle ABF are respectively equal to the sides DB, BC and the included angle DBC.
Therefore the base AF is equal to the base DC. (I. 4.)—
[Q. E. D.]

Arithmetic.

GIRLS ONLY.

1. *(a)* State clearly the meaning of each of the following terms :—Integer, Fraction, Numerator, Denominator, Proper Fraction, Improper Fraction, and give examples in illustration of your answer.

(b) Define a 'Decimal Fraction,' and show how it differs from a Vulgar Fraction. Express each figure of ·02736 as an equivalent Vulgar Fraction.

(a) An *Integer* means a whole or unbroken number, or an exact number of units, as 5.

A *Fraction*, literally a *broken* number, means a part of a unit or of a number of units, as one-third, two-fifths, written $\frac{1}{3}$, $\frac{2}{5}$.

The *Numerator* of a fraction is the number which indicates how many parts the fraction stands for, or what number of units is divided to produce it. It is placed over a small line, as 1 in $\frac{1}{3}$, 2 in $\frac{2}{3}$.

The *Denominator* of a fraction indicates the number of parts into which a unit is understood to be divided, or the divisor of the units expressed by the numerator. It is usually placed under a line, as 3 in $\frac{1}{3}$, 5 in $\frac{2}{5}$.

A *Proper Fraction* is less than a unit : its numerator is always less than its denominator, as $\frac{1}{2}$, $\frac{2}{3}$.

An *Improper Fraction* is equal to a unit, or greater than a unit. Its numerator is either equal to or greater than its denominator, as $\frac{3}{3}$, or $\frac{4}{3}$.

(b) A Decimal Fraction is a fraction whose denominator is always ten or some power of ten. It differs from a Vulgar Fraction in having the denominator always understood, instead of being expressed. Thus a dot is placed before the figure or figures representing the decimal fraction, the first figure after the dot, or decimal point as it is called, stands for so many tenths, the following one for so many hundredths, the next for thousandths. In the example given ·02736, the 0 stands for no tenths $\frac{0}{10}$, 2 for $\frac{2}{10}$ or $\frac{1}{5}$, 7 for $\frac{7}{1000}$, 3 for $\frac{3}{10000}$, 6 for $\frac{6}{100000}$, and the whole for $\frac{2736}{100000}$.

2. Simplify—

$$1 - \left(\frac{2\frac{1}{3} + \frac{2}{3} - \frac{1}{12}\text{ of }6}{1\frac{1}{2} + \frac{1}{12}\text{ of }\frac{3}{1\frac{1}{2}} - \frac{1}{3}} \div \frac{\frac{1}{4} + \frac{1}{2}}{\frac{1}{4} - \frac{1}{5}} + \frac{\cdot 08}{\cdot 125} \right)$$

$$= 1 - \left(\frac{\frac{7}{3} + \frac{2}{3} - \frac{1}{2}}{\frac{3}{2} + \frac{1}{2} - \frac{1}{2}} \div \frac{5 + 4}{5 - 4} + \frac{\cdot 08}{\cdot 125} \right)$$

$$= 1 - \left(\frac{70 + 18 - 15}{15 + 25 - 10} \div \frac{9}{1} + \frac{\cdot 08}{\cdot 125} \right)$$

$$= 1 - \left(\frac{73}{30} \div 9 + \frac{\cdot 08}{\cdot 125} \right)$$

$$= 1 - \left(\frac{73}{270} + \frac{\cdot 08}{\cdot 125} \right)$$

$$= 1 - \frac{640}{1000} = \underline{\frac{360}{1000}}. \text{ Ans.}$$

3. *(a)* Find the cost of papering a room $8\frac{1}{2}$ yards long, 6 yards 2 feet wide, and $4\frac{1}{2}$ yards high, with paper 2 feet wide, at 4d. per yard.

Distance round the room $= (8\frac{1}{2}\text{ yds.} \times 2) + (6\text{ yds. }2\text{ ft.} \times 2)$
$= 16\frac{1}{2}\text{ yds.} + 13\text{ yds. }1\text{ ft.} = 29\text{ yds. }2\text{ ft. }6\text{ in.}$
Number of widths of paper required to go round room
$$= \frac{29\text{ yds. }2\frac{1}{2}\text{ ft.}}{2\text{ ft.}} = \frac{89\frac{1}{2}}{2} = 44\tfrac{3}{4}$$
$\therefore$ No. of yds. required $= 44\frac{3}{4} \times 4 = 179$
And Cost of 179 yds $= \frac{179}{3}$s. $= 59$s. 8d. $= \underline{£2\ 19\text{s. }8\text{d.}}$ Ans.

(b) Given the length of a room to be 20 feet 6 inches, and area of floor 35 square yards 7 square feet 126 square inches, find the breadth of the room.

Breadth = Area ÷ Length.
= 35 sq. yds., 7 sq. ft., 126 sq. in. ÷ 20 ft. 6 in.
= 322 sq. ft., 126 sq. in. ÷ 20 ft. 6 in.
$= 322\frac{7}{8}\text{ sq. ft.} \div 20\frac{1}{2}\text{ ft.}$
$= \frac{2583}{8} \div \frac{41}{2}$
$= \frac{63}{\cancel{2583}} \times \frac{\cancel{2}}{41} = \frac{63}{4}$
$= \underline{15\text{ ft. }9\text{ in.}}$ Ans.

4. What fraction of 13 lbs. 7 oz. 5 dwts. 15 grs. is equal to 8 lbs. 1 oz. 19 dwts. 9 grs. ?

$$\text{Fraction} = \frac{8\text{ lbs. }1\text{ oz. }19\text{ dwts. }9\text{ grs.}}{13\text{ lbs. }7\text{ ozs. }5\text{ dwts. }15\text{ grs.}}$$
$$= \frac{97\text{ ozs. }19\text{ dwts. }9\text{ grs.}}{163\text{ ozs. }5\text{ dwts. }15\text{ grs.}}$$
$$= \frac{1959\text{ dwts. }9\text{ grs.}}{3265\text{ dwts. }15\text{ grs.}} = \frac{47049}{78375} = \frac{15683}{26125}$$
$$= \frac{1711}{2852} = \frac{187}{311} = \underline{\frac{17}{28}}. \text{ Ans.}$$

5. A man has a garden with five different kinds of trees in it, and of these $\frac{1}{4}$ are apple trees, $\frac{2}{9}$ pear trees, $\frac{1}{6}$ plum trees, and $\frac{1}{12}$ cherry trees. Besides these trees there are 20 apricot trees. Find how many trees there are altogether in the garden.

Of the total number of trees in the garden, the apple, pear, plum, and cherry trees amount to $\frac{1}{4} + \frac{2}{9} + \frac{1}{6} + \frac{1}{12}$
$$= \frac{9 + 8 + 6 + 3}{36} = \frac{26}{36} = \frac{13}{18}.$$
Therefore the remaining number $= \frac{5}{18}$ of the whole.
Since $\frac{5}{18} = 20$, $\frac{1}{18} = \frac{20}{5} = 4$ trees,
and $\frac{18}{18}$ that is the whole number $= 4 \times 18 = \underline{72}$. Ans.

BOYS AND GIRLS.

Grammar.

1. *Far up* the *lengthening* lake were *spied*
Four *darkening* specks upon the tide,
That, slow enlarging on the view
Four manned and masted *barges grew*,
And, bearing *downwards* from Glengyle,
Steered full upon the opening isle.

Turn this passage into prose.

On a distant part of the far reaching loch appeared four small dark objects, looking like floating specks on the water. As they drew nearer they gradually assumed larger proportions to the sight, and proved to be four vessels fitted with masts and sails and provided with oarsmen ; and coming down from Glengyle they were guided directly towards the island whence they had been observed.

2. Analyse the above passage, and parse the words in italics.

a. Far up the lengthening lake were spied
Four darkening specks upon the tide.
Principal clause to *b* and *c*.

b. That, slow enlarging on the view
Four manned and masted barges grew.
Subordinate clause, attributive to 'specks' in *a*.

c. And, bearing downwards from Glengyle,
Steered full upon the opening isle.
Subord. clause to *a*, co-ordinate to *b*, attrib. to 'specks.'

a.	(1) Far up the lengthening lake	Extension of pred. (place)
	(2) were spied	Predicate.
	(3) Four darkening specks	Subject with two attributives.
	(4) upon the tide	Extension of pred. (place).
b.	(1) That = which	Subject.
	(2) slow enlarging on the view	Participial phrase, attrib. to subj.
	(3) Four manned and masted barges	Complement to pred.
	(4) Grew	Predicate (incomplete).
	and	Connective.
c.	(1) [that] understood	Subject.
	(2) bearing downwards from Glengyle	Participial phrase, attrib. to subj.
	(3) steered	Predicate.
	(4) full upon the opening isle	Extension of predicate (place, direction).

Far—adverb of place, modifying 'up the lake.'
up—preposition, gov. 'lake.'
lengthening—participial adjective, from verb 'lengthen,' attrib. to 'lake.'
spied—participle, passive of verb 'spy,' forming with 'were' verb, reg., trans., passive voice, indic. mood, past tense, 3rd pers., plural num., agr. with nominative 'specks.'

That—pronoun, relative, 3rd person, plural num. neuter gend., agr. with antecedent 'specks,' nominative case subj. to 'grew' and 'steered.'
slow = *slowly*—adverb of manner modifying participle 'enlarging.'
enlarging—participle, incomplete, of verb to enlarge, attrib. to 'that.'
barges—noun, common, 3rd pers., plur. num., neut. gend., nominative case, following intransitive verb 'grew.' (Rule. The verb to be and some other intransitive verbs take the same case after as before when the nouns or pronouns signify the same person or thing.)
grew—verb, irreg. intrans., indic. md., past tense, 3rd pers., plur. num., agreeing with subject 'that.'
downwards—adverb of place (direction), modifying 'bearing.'
steered—verb, reg. intrans., indic. md., past tense, 3rd pers., plur. num., agreeing with subject 'that.'
full—adverb of manner, modifying 'steered.'

3. What is the meaning of ad, ex, and ob? Give words in which they occur. How and when are they sometimes changed in composition?

Ad is a Latin prefix meaning *to* or *for*, as in adhere, meaning to stick to; adduce, to draw to; advise.
Ex is a Latin prefix which means *out of*, as in extract, to draw out; express; exit.
Ob, a Latin prefix, which means *in front of*, as in obstacle, that which stands in front of, or in the way of something; obdurate, obtain.
These prefixes are modified in form when the following syllable begins with some consonant with which they will not easily combine. Thus *ad* becomes *af* in affect, *ac* in accede, *ar* in arrogate, *as* in assume, *at* in attract, *an* in announce, *ag* in aggressive, *ap* in appreciate.
Ex becomes *e*, *ec*, *ef*, in eject, eccentric, efface.
Ob becomes *oc*, *of*, *op*, in occur, offend, oppress.

Geography.

(Do *three* questions only.)

1. Describe a journey from London to Constantinople by land, with a return home by water.

Leaving London by the South-Eastern Railway or the London, Chatham and Dover Railway, the traveller would first proceed to Dover. Thence he would take the packet for Ostend, and take train for the handsome city of Brussels, capital of Belgium, and an important railway centre. From Brussels he could go by railway to Vienna, passing the well-known towns of Aix-la-Chapelle, and Cologne, the latter famous for its cathedral and its manufacture of perfumery, and travelling up the Rhine Valley to Coblentz at the confluence of the Maine with the Rhine, on to Frankfort-on-the-Maine, up the Maine to Nuremburg, then into the valley of the Danube to Ratisbon, and so on down the Danube to Vienna, the remarkably fine capital of Austria, which is next to Paris the most populous city in Europe. The railway could still be followed down the Danube to Buda-Peath, the twin cities forming the capital of Hungary, and then in a south-easterly direction to Bucharest, in Roumania. Crossing this State still by railway, the traveller would enter Turkey proper, and near Widdin would have to leave the Danube to turn south towards Sophia, and then cross one of the Balkan Passes to Philippopolis. Thence a railway would take him past Adrianople to Constantinople, his destination.

To effect his return by sea he would take steamer in the harbour of the Golden Horn, and pass through the Bosphorus or Strait of Constantinople into the Sea of Marmora. Crossing this sea in a south-westerly direction he would pass through the long narrow strait known as the Dardanelles, or Hellespont, and then enter the island-studded sea called the Archipelago. Proceeding south he would leave to the west Negropont and the peninsula of Greece, rounding the latter near Cape Matapan, the most southern point of Europe. He would then most probably take in his course Valetta, the capital of Malta, an island lying to the south of Sicily. He would then keep almost directly west to Gibraltar, another British possession, famous for its almost impregnable natural fortifications. Turning this rock he would skirt the coast of Spain and Portugal, then cross the stormy Bay of Biscay, and, passing the peninsula of Brittany, steam into the English Channel, up which he would proceed in an easterly direction, turning north after passing Dungeness, and then west into the mouth of the Thames, and proceeding up the river for about 40 miles to London Bridge.

2. What are the chief productions of India? Describe the position of the different ports from which they will be sent to us.

The principal natural products of India are cotton, rice, opium, indigo, silk, sugar, coffee, spices, sandal-wood, jute, skins, pearls, tea, teak. Amongst manufactures may be named Cashmere shawls, carpets, ivory-carvings, filigree-work, chintzes.

The chief ports from which many of these goods are exported to Britain are Calcutta, Bombay, Surat, Cambay, Kurrachee, Calicut, Madras, Colombo.

Calcutta is the seat of government, and is situated on the Hooghley, one of the mouths of the Ganges. It is about 100 miles from the sea.

Bombay, a very large city and seaport, stands on the island of Bombay on the western coast of Hindostan.

Cambay is situated at the head of a gulf of the same name on the western side of India north of Bombay.

Surat, famous for the export of cotton, stands at the mouth of the Taptee, about midway between Bombay and Cambay.

Kurrachee, in the province of Scinde, occupies the most western corner of India, being close to the boundary of Beloochistan.

Calicut, also on the western coast, is near the southern extremity of the peninsula.

Madras, though it has large trade, is without the advantage of any good harbour. It stands on the eastern or Coromandel coast in the southern part of Hindostan.

Colombo is the capital of Ceylon, and is situated on its western coast.

3. With what object and in what manner are the degrees of latitude and longitude calculated? Give as nearly as you can the latitude and longitude of Paris.

The chief practical use of degrees of latitude and longitude is as a means of fixing and describing the exact position of places on the earth's surface. Latitude, which literally means breadth, is measurement in a north and south direction; longitude, meaning length, is measurement east and west. For the purpose of indicating position as determined by latitude and longitude circles are drawn round globes, and corresponding lines are drawn on maps. The circumference of the earth midway between the poles is distinguished as the equator. From this latitude is measured north and south by means of circles parallel to the equator, and hence called parallels of latitude. The distance from the equator to each pole being one-fourth of the earth's circumference is divided into 90 degrees, and the parallel circles are placed at equal distances apart, the number of degrees between two successive lines being such as the size of the map or globe renders convenient. The latitude of places may thus vary from 0 on the equator to 90 degrees N., at the north pole, or 90° S. at the south pole.

Longitude is measured along the equator or any circle parallel to it, and for the purpose of reckoning this measurement circles are drawn round the globe passing through the two poles and cutting the equator at right angles. These lines are called meridians from the fact that all the places on any one of the semicircles from the north to the south pole have mid-day at the same time (Latin, *meridies*, mid-day). Some particular meridian is chosen to measure from, and distance east or west of this is called E. or W. longitude. A place half-way round the globe from the first meridian will have its longitude 180 degrees E. or W., and this is the greatest longitude any place can have. In English maps, and many others, the first meridian is that which passes through Greenwich. In French maps the line passing through Paris has been adopted. If we know the latitude of a place we can find the parallel on which it is situated, and if we know the longitude also we can find the meridian on which it stands, that is the particular part of the parallel it occupies; thus its position is exactly fixed.

Paris is in latitude 49° N. or nearly so, and about 2½° west longitude.

4. Draw a map of the basin of the Euphrates, or the Volga.

SECOND PAPER.

(Two hours and a half allowed.)

Needlework.

GIRLS ONLY.

(One hour allowed for this exercise.)

Make a band with calico, on it work a button-hole, set on a button, hem, whip and set on a frill.

BOYS ONLY.

Arithmetic.

1. In a school of four sections the first contained 16 per cent., the second 22 per cent., the third 30 per cent. of the scholars, and the fourth section contains 80 scholars. How many scholars are in the first, second, and third sections respectively?

$16 + 22 + 30 = 68 =$ per centage in first three sections
$100 - 68 = 32 =$ " " fourth section
Since 32 per cent. $= 80$, 16 per cent. $= \frac{80}{2} = 40$
22 per cent. $= 80 \times \frac{22}{32} = 5 \times 11 = 55$
30 per cent. $= 80 \times \frac{30}{32} = 5 \times 15 = 75$
40, 55, and 75. Ans.

2. A tradesman takes off 5 per cent. for ready money, and a purchaser pays £61 15s. of ready money. What was the whole bill?

Since 5 per cent. is allowed for ready money, the actual payment is 95 per cent, or $\frac{19}{20}$ of the original amount.
$\frac{19}{20}$ of bill $=$ £61 15s.
∴ the bill $=$ £61 15s. $\times \frac{20}{19} =$ £3 5s. $\times$ 20 $=$ £65. Ans.

3. At what rate per cent. per annum will £1501 5s. amount to £1553 15s. 10½d. in 1 year 146 days?

Interest on £1501 5s. for 1 yr. 146 days, or 1⅔ yrs.
$=$ £1553 15s. 10½d. $-$ £1501 5s. $=$ £52 10s. 10½d.
∴ Interest for 1 yr. $=$ £52 10s. 10½d. $\times \frac{3}{5}$ $=$ £7 10s. 1½d.
$\times$ 5 $=$ £37 10s. 7½d.
and interest on £100 for 1 yr. $=$ £37 10s. 7½d. $\times \frac{100}{\text{£1501 5s.}}$
$=$ £37 10s. 7½d. $\times \frac{80}{1201} = \frac{\text{£3002 10s. 0d.}}{1201} =$ £2½
2½ per cent. Ans.

4. If the difference between the true and banker's discount on a bill due twelve months hence be 5s., interest being at 4 per cent. per annum, find the amount of the bill.

The true discount on £104 at 4 % for 12 months $=$ £4, that is $\frac{1}{26}$ of the amount.
Banker's discount on £100 at 4 % for twelve months $=$ £4, that is $\frac{1}{25}$ of the amount.
Therefore $\frac{1}{25} - \frac{1}{26}$ $=$ the difference expressed as a fraction of the amount.

$\frac{1}{25} - \frac{1}{26} = \frac{26 - 25}{650} = \frac{1}{650}$ of the bill $=$ 5s.
∴ the bill $=$ 5s. $\times$ 650 $=$ £162 10s. Ans.

History.

BOYS AND GIRLS.

1. Distinguish the families which occupied the English throne between Edward the Confessor and James I. Tell the nation to which each belonged, with the date of first accession, and name the Sovereign of each House whom you regard as the most illustrious.

(1.) Edward the Confessor was immediately succeeded on his death in 1066 by Harold, son of Earl Godwin. He was a Saxon, and being the only Sovereign of his family was of course the most illustrious. He held the throne a very short time.

(2.) The Norman line began with William the Conqueror in 1066. This family was of French origin, and included four kings: William I., William II., Henry I., and Stephen, the most distinguished being William I, the Conqueror.

(3.) The House of Plantagenet began with Henry II. This family was French, the first king being Count of Anjou, in France. Henry II. began to reign in 1154. He was followed by seven other Sovereigns in direct descent from him. The most illustrious was Edward I., who, for his excellent legal institutions, has been called the English Justinian.

(4.) The House of Lancaster was a branch of the Plantagenet line. Its first Sovereign, Henry IV., was descended from a younger son of Edward III., and began to reign in 1399. This line included three kings, of whom the second, Henry V., was the most renowned.

(5.) The House of York was descended from an elder branch of the Plantagenet family. The first King of this line was Edward IV., who began to reign in 1461. Edward IV. was the most eminent of the Yorkists, though his brother, Richard III., is more familiarly known through the crimes attributed to him. The Houses of York and Lancaster are sometimes included in the Plantagenet dynasty, which in that case numbers fourteen Sovereigns, of whom Edward I. was probably the greatest.

(6.) The House of Tudor followed the Yorkists. The first Sovereign, Henry VII., ascended the throne in 1485. He was of Welsh descent. He was succeeded by his son Henry VIII. and his three grandchildren—Edward VI., Mary, and Elizabeth, the last of whom was undoubtedly the most illustrious sovereign of the family. She was succeeded by James I.

2. On Saturday, July 21st, 1403, was fought on the plain near Shrewsbury 'one of the wyrste bataylys that ever came to Inglande and unkyndyst,' a day 'rather to be celebrated with teares than triumphs.'' Narrate events which led to this battle, and its results.

The Percies of Northumberland claimed to have been instrumental in helping Henry IV. to secure the English throne; but shortly after his accession they found several grounds of discontent. The Scottish Earl Douglas, a hereditary foe of Percy, had been defeated and taken prisoner, and a dispute arose between Percy and the King as to the disposal of the prisoner. Henry, son of Percy, surnamed Hotspur, from his fiery spirit, desired the King to ransom from the Welsh his kinsman Edmund Mortimer, and being refused this request, and also being denied the wardenship of the Marches he raised an army in revolt against Henry, and was helped by Earl Douglas, who had been liberated, and by Owen Glendower, a Welsh chieftain. The King encountered Hotspur's forces near Shrewsbury, and as the Severn, which almost surrounds the town, was in flood at the time Owen Glendower could not reinforce Hotspur as he wished. The result was that Hotspur was killed in the battle and his army dispersed. Northumberland had been prevented by illness from joining in the battle. He submitted and was pardoned, but afterwards revolted again, and was defeated at Tadcaster in 1408. The battle of Shrewsbury secured Henry's ascendency; but it is bewailed by the historian on account of the great losses it involved.

3. 'I have had pleasure in looking at William Rufus's rusty stirrup, and the worm-eaten chair in which Queen Mary sat when she was married in the cathedral of Winchester to King Philip of Spain.' Give dates with some particulars of the Sovereigns mentioned.

William Rufus, third son of William I., ascended the throne of England in 1087, and ruled till 1100. He received the name Rufus from his ruddy complexion. He had unjustly usurped the throne which should have been occupied by Robert. His selfishness and cruelty caused him to be hated by every class of his subjects. He quarrelled with the clergy, especially Anselm, Archbishop of Canterbury, on a question of investiture. It was his practice to keep ecclesiastical offices vacant, and to keep the revenues for himself, and on appointments being made he exacted heavy fines. The King forced Anselm to take the Archbishopric of Canterbury in 1093, and demanded a large sum on his appointment. Anselm was unable to pay so much, and offered a smaller sum. This was refused, and the Archbishop, being driven from the kingdom, appealed to the Pope. Robert, anxious to join the Crusades which were just beginning, pledged his dominions in France to William, and, during his absence in the Holy Land, William Rufus was slain by an arrow while he was hunting in the New Forest. Whether this was the result of accident or design is uncertain.

Mary was the daughter of Henry VIII. and Catherine of Aragon. She succeeded her half-brother Edward VI. in 1553. She married Philip II. of Spain in 1554. Her great desire was to re-establish the Roman Catholic ascendancy in England. On her marriage with Philip she became more anxious to do this in the hope that her husband would be the better pleased. He was, however, a cold, hard man, and all her efforts to secure his affection were unavailing. Her reign is stained with the cruel persecution of those Protestants who refused to accept the Romish doctrines. Nearly 300 persons suffered death at the stake on account of their religious opinions; among them were

the prelates Cranmer, Ridley, Latimer, and Hooper. In 1557 Mary supplied forces to help Philip in his war on the Netherlands, and though the English gained the battle of St. Quentin, this was followed early in 1558 by the loss of Calais, the last of the English possessions in France. This loss preyed on the mind of the Queen, and she died with her spirit broken by the neglect of her husband, the discontent of her people, the disappointment of her hopes.

Philip II. of Spain was one of the most powerful Sovereigns of his time. He ruled over Spain from 1556 to 1598. He married Mary, as above recorded, with the idea of securing sovereign power in England. With the same idea he afterwards wished to marry her successor Elizabeth, and, being refused, he sent over the Armada in 1588 to attempt the conquest of the kingdom.

Teaching.

What points would you chiefly keep in view in giving a dictation lesson?

The most obvious use of the exercise called dictation is as a test of previous instruction. But if dictation is to be considered as a lesson, the first point to be kept in view is that it should be specially prepared for. The passage to be dictated, or the reading from which it is selected, or at least the more difficult words it contains, should be appointed for study. The reason for this is that if the piece dictated contains peculiar words not previously learnt, guessing is encouraged, and incorrect spelling may become impressed on the eye and on the mind, so that much labour may be required to correct the wrong impression.

With the kind of preparation here indicated dictation may be made a means of real instruction, just as working questions in arithmetic is the proper lesson to follow an explanation of a rule or process, so as to impress the matter on the mind. Still dictation is practically a test of the result of instruction. In order to be a fair test it is necessary that the words shall be distinctly uttered, and that enough time shall be allowed for the pupils to write them down. Sentences should be broken up into phrases short enough to be easily remembered, and a pause should be made after each phrase. Then it is important that the work shall be fairly done by the pupils. The best security for this is to be found in a good moral tone developed in the class, supplemented by effective but not suspicious watchfulness on the part of the teacher. Such devices as giving two or more pieces to scholars intermingled, so that no two sitting next each other shall have the same passage, or insisting on every child guarding his work from his neighbour's eyes, ought not to be necessary, though they are frequently adopted on account of the consequences made to depend on the results of the instruction.

Another point to be borne in mind is that the dictation lesson should be made a practical lesson in writing. The pen should be properly held, and the letters well formed. There is a danger sometimes that the spelling alone may be thought of, and the writing may be allowed to degenerate into mere scribble. Care should also be taken that the insertion of omitted words or letters, and the correction of mis-spelt words on a second reading should be as infrequent as possible.

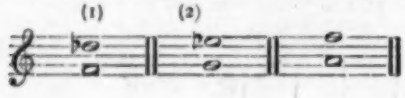
Frequent repetition should be avoided. It will not be necessary if careful attention to the first reading be insisted on, if the phrases read are not too long, and if the children are not allowed to write while the words are being dictated. If the class is large a single repetition after the first reading may be allowable.

After completion the exercises should be carefully corrected, and the safest plan for doing this is for the teacher to examine each exercise himself, however tedious the process may be. Then each mistake should be pointed out, and the pupils who have made errors should re-write the words correctly so as to impress the proper spelling on their memory. Where the size of the class renders correction of the individual papers by the teacher an impossibility, the plan of changing books may be adopted, and the scholars allowed to correct each other's exercises while the passage is spelt over to the class.

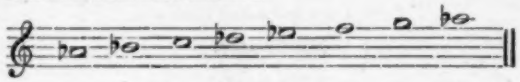
Music.

1. Add a minor sixth above each of the following notes.

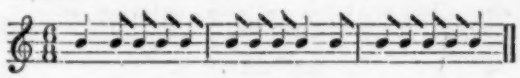
(1) (2)



2. Write the scale of A flat major, placing the necessary flats before the notes to be flattened.



3. Add bars to the following in accordance with the time-signature.



TONIC SOL-FA NOTATION.

1. Between which tones of the diatonic scale is there the interval of a minor sixth.

me and *doh'*, *lah* and *fah'*, *te* and *soh'*.

2. What is the mental effect of (1) *lah*, (2) of *me*, (3) of *soh*.

(1) *lah*, sad, mournful. (2) *me*, calm, peaceful. (3) *soh*. bold, martial.

3. What measures are shown by the following pulse signs?

(1) | : : | : : | : : | : : |

Six-pulse, secondary form.

(2) | : | : | : | : ‖

Four-pulse, secondary form.

(3) | : : | : : | : : | : : | : : | : : |

Nine-pulse, secondary form.

END OF THIRD YEAR.

Three hours and a half allowed.

BOYS ONLY.

Euclid.

[All generally understood abbreviations for *words* may be used, but not symbols of operations, such as −, +, ×.]

Answer two questions, including Question 3, if you can do so.

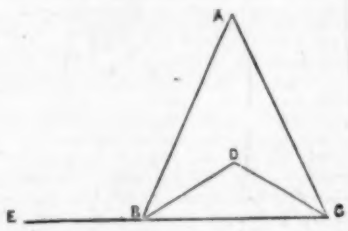
1. If a side of any triangle be produced, the exterior angle is equal to the two interior and opposite angles; and the three interior angles of every triangle are together equal to two right angles.

Book I. Proposition 32.

2. The complements of the parallelograms, which are about the diameter of any parallelogram, are equal to one another.

Book I. Proposition 43.

3. If the straight lines bisecting the angles at the base of an isosceles triangle be produced to meet, they will contain an angle equal to an exterior angle at the base of the triangle.



Let ABC be an isosceles triangle having the side AB = to the side AC.

Bisect the angles ABC, ACB, by the lines BD, CD, meeting in D (I. 9).

Produce CB to E making the exterior angle ABE.

Then the angle BDC shall be equal to the angle ABE.

Because ABC is an isosceles triangle (Hyp.),

Therefore the angles ABC, ACB at its base are equal to each other (I. 5).

But DBC, DCB are halves of the angles ABC, ACB (Const.) Therefore the angle DBC is equal to the angle DCB (Ax. 7).

Therefore the angles DBC, DCB are together double of the angle DBC, and so equal to the angle ABC (Ax. 6).

But the angles ABC, ABE are together equal to two right angles (I. 13).

Also the three angles DBC, DCB, and BDC of the triangle DBC are together equal to two right angles (I. 32).

Therefore the two angles ABE, ABC are equal to the three angles DBC, DCB, BDC (Ax. 1).

From these equals take away the equal parts, the angle ABC, and the angles DBC, DCB, and the remaining angles ABE, BDC are equal (Ax. 3). Q.E.D.

Algebra.

(Answer two questions, including question 3, if you can do so.)

1. Show that $(11a + 10b + c)^2 - (a + 10b + 11c)^2 = 120\left(a - c\right)\left(a + c + \frac{5b}{3}\right)$, and find its value when $a = -1$, $b = -3$, $c = -2$.

$$(11a + 10b + c)^2 - (a + 10b + 11c)^2$$
$$= (11a + 10b + c - a - 10b - 11c)\,(11a + 10b + c + a + 10b + 11c)$$
$$= (10a - 10c)\,(12a + 20b + 12c)$$
$$= 10\,(a - c) \cdot 12\,(a + c + \tfrac{10}{6}b)$$
$$= 120\left(a - c\right)\left(a + c + \frac{5b}{3}\right)$$

Applying given values

$$120\left(a - c\right)\left(a + c + \frac{5b}{3}\right)$$
$$= 120\left\{-1 - (-2)\right\}\left(-1 - 2 - 1\tfrac{2}{3}\right)$$
$$= 120\,(-1 + 2)\,(-3 - 5)$$
$$= 120 \times 1 \times (-8)$$
$$= -960$$

If the same values are applied to the first expression it becomes $(-43)^2 - (-53)^2$
$= 1849 - 2809 = -960$ as before.

$\underline{-960}$. Ans.

2. Reduce to lowest terms $\dfrac{3x^3 - 10ax^2 + 7a^2x}{7x^3 - 10ax^2 + 3a^2x}$, and $\dfrac{3ax^2 + 10a^2x + 7a^3}{7ax^2 + 4a^2x - 3a^3}$, and add them together.

$$\frac{3x^3 - 10ax^2 + 7a^2x}{7x^3 - 10ax^2 + 3a^2x} = \frac{x\,(3x^2 - 3ax - 7ax + 7a^2)}{x\,(7x^2 - 7ax - 3ax + 3a^2)}$$
$$= \frac{3x\,(x - a) - 7a\,(x - a)}{7x\,(x - a) - 3a\,(x - a)} = \frac{3x - 7a}{7x - 3a}.$$
$$\frac{3ax^2 + 10a^2x + 7a^3}{7ax^2 + 4a^2x - 3a^3} = \frac{a\,(3x^2 + 3ax + 7ax + 7a^2)}{a\,(7x^2 + 7ax - 3ax - 3a^2)}$$
$$= \frac{3x\,(x + a) + 7a\,(x + a)}{7x\,(x + a) - 3a\,(x + a)} = \frac{3x + 7a}{7x - 3a}.$$
$$\frac{3x - 7a}{7x - 3a} + \frac{3x + 7a}{7x - 3a} = \frac{3x + 3x - 7a + 7a}{7x - 3a} = \frac{6x}{7x - 3a}.$$

$\underline{\dfrac{3x - 7a}{7x - 3a}, \dfrac{3x + 7a}{7x - 3a}, \dfrac{6x}{7x - 3a}}$. Ans.

3. Prove that in any equation any quantity may be transferred from one side to the other without affecting the result, the sign of the quantity so transferred being changed.

Solve (1) $81 - 7\left\{2x - 3(x - 4)\right\} = \dfrac{x - 3(8 - 5x)}{16}$

(2) $\dfrac{(a + b)(b - x)}{a - b} + x = 0$

(*a*) Let the equation be $x + a = b - c$

Since taking an equal quantity from each side will not alter the equality, take a from each side

$\therefore x + a - a = b - c - a$

And since adding an equal quantity to each side will not alter the equality add c to each side

$\therefore x + a - a + c = b - c - a + c$
that is $x + c = b - a$

This result would be obtained by transferring $+ a$, and $- c$, to the opposite sides of the equation with the sign changed in each case, and the same operation can always be performed with the like result.

(1) $81 - 7\left\{2x - 3(x - 4)\right\} = \dfrac{x - 3(8 - 5x)}{16}$

Remove inner brackets

$\therefore 81 - 7\left\{2x - 3x + 12\right\} = \dfrac{x - 24 + 15x}{16}$

Remove other brackets

$\therefore 81 - 14x + 21x - 84 = \dfrac{16x - 24}{16}$

Simplify

$\therefore 7x - 3 = x - 1\frac{1}{2}$

Transpose

$\therefore 7x - x = 3 - 1\frac{1}{2}$

that is $6x = 1\frac{1}{2}$

$\therefore x = 1\frac{1}{2} \div 6 = \frac{1}{4}$.

$\underline{x = \frac{1}{4}}$. Ans.

(2) $\dfrac{(a + b)(b - x)}{a - b} + x = 0$

Multiply by $a - b$

$(a + b)(b - x) + (a - b)x = 0$

Remove Brackets

$\therefore ab + b^2 - ax - bx + ax - bx = 0$

Collect and Transpose

$\therefore -2bx = -ab - b^2$

Divide by $-2b$

$\therefore x = \dfrac{a + b}{2}$. Ans.

Mensuration.

(Answer one question.)

1. Find the difference between the area of a triangle whose sides are 16, 63, 65, and the area of a square whose perimeter is the same as that of the triangle.

Using the formula for area of triangle when three sides a, b, c, are given, and $s = \frac{1}{2}$ the sum of the three sides,

Area of tri. $= \sqrt{s\,(s - a)\,(s - b)\,(s - c)}$
$= \sqrt{72 \times (72 - 16) \times (72 - 63) \times (72 - 65)}$
$= \sqrt{72 \times 56 \times 9 \times 7}$
$= \sqrt{8 \times 9 \times 8 \times 7 \times 9 \times 7}$
$= 8 \times 9 \times 7 = 504$ sq. units.

Area of square $= \left(\dfrac{16 + 63 + 65}{4}\right)^2$
$= (14\frac{1}{4})^2 = 36^2 = 1296$ sq. units.

$\therefore$ Area of square exceeds that of triangle by $1296 - 504$ that is $\underline{792}$. Ans.

2. Two sides of a parallelogram are 4 feet and 4 feet 7 inches, and a diagonal is 6 feet 1 inch; determine whether it is a rectangle, and find its area in square yards and decimals of a square yard.

4 ft. = 48 in. and $48^2 = 2304$
4 ft. 7 in. = 55 in. and $55^2 = 3025$
6 ft. 1 in. = 73 in. and $73^2 = 5329$.

The latter, that is the square of the diagonal, is equal to the sum of the other two squares, that is to the sum of the squares on the two sides. Hence by the 48th Prop. of Euclid, Bk. I., the angle contained by the two sides is a right angle, and the parallelogram is therefore a rectangle.

Area of rectangle $= \dfrac{48 \times 55}{144} = \dfrac{55}{3} = 18\cdot\dot{3}$ sq.ft. $= 2\cdot0\dot{3}7$ sq. yds.

Answer. The parallelogram is a rectangle, and its area is $2\cdot0\dot{3}7$ sq. yds.

Arithmetic.

GIRLS ONLY.

1. If 3 men and 4 boys can do a certain amount of work in 12 days, in how many days could 2 men, 1 boy, and 1 woman do a similar amount, supposing that 1 woman does as much as 2 boys, and 1 man as much as a woman and a boy together?

Work of 1 man = work of 1 woman + 1 boy = work of 2 boys + 1 boy that is of 3 boys.

$\therefore$ Work of 3 men and 4 boys = work of 9 boys + 4 boys, that is of 13 boys, and work of 2 men, 1 woman, and 1 boy = work of 6 boys + 2 boys + 1 boy, that is of 9 boys.

Since 13 boys would do the work in 12 days
1 boy ,, ,, in 12×13 days
and 9 boys ,, ,, in $\dfrac{12 \times 13}{9} = 17\frac{1}{3}$

$= \underline{17\frac{1}{3}\text{ days.}}$ Ans.

2. What is meant by a 'Recurring Decimal'?

(*a*) State the rules for reducing 'terminating' and 'circulating' decimals to Vulgar Fractions. Give numerical examples.

A Recurring Decimal is a fraction which cannot be exactly expressed as a vulgar fraction with 10 or some power of 10 for its denominator. It usually results from division by a number which contains other prime factors than 2 and 5. This division does not terminate, but in the couse of the division the same number must sooner or later be the remainder, and from this point the figures in the quotient will repeat in the same order. The same remainder may recur at every step, then the quotient will consist of a series of the same digit. Thus when $\frac{2}{3}$ is converted into a decimal the result is ·666.....and so on. This result is indicated by placing a dot over the figure thus ·6̇, and dropping the repetitions. In converting $\frac{4}{7}$ into a decimal we have as a result ·285714 when the remainder is 2 and therefore the same set of figures would be repeated. This is denoted by writing the series of figures once and placing dots over the first and last of the period, thus $\frac{4}{7}$ = ·2̇8571̇4̇.

(*a*) To reduce a terminating decimal to a vulgar fraction put the decimal figures in the place of the numerator, and for a denominator put the figure 1 followed by as many ciphers as there are figures after the decimal point, and then reduce to lowest terms if necessary. Thus ·5 = $\frac{5}{10}$ = $\frac{1}{2}$; ·368 = $\frac{368}{1000}$ = $\frac{46}{125}$; ·00375 = $\frac{375}{100000}$ = $\frac{3}{800}$.

To reduce a 'recurring' decimal to a vulgar fraction, put for the numerator the number found by subtracting the non-repeating portion of the decimal figures, if any, from the whole of the figures after the decimal point, and put for the numerator as many nines as there are repeating figures followed by as many ciphers as there are non-repeating figures, and if necessary reduce to lowest terms. Thus ·6̇ = $\frac{6}{9}$ = $\frac{2}{3}$ ·41̇6̇ = $\frac{416-4}{990}$ = $\frac{412}{990}$ = $\frac{206}{495}$.

(*b*) If after dividing the sum of 150·3, ·088, 284, 3·005, and 7 thousandths by a certain number the *quotient* be 9·72, what is the divisor?

150·3 + ·088 + 284 + 3·005 + ·007 = 437·400
437·4 ÷ 9·72 = 45. Ans.

3. Find the value of—

2·625 of 1s. — $\frac{3}{4}$ of $\frac{2}{3}$ of 5s. 4d. + $\frac{1}{2}$ of 17s. 8d. + ·263 of £1 5s., and reduce the result to the decimal of £5.

(N.B.—Work to 5 places of decimals.)

2·625 of 1s. — $\frac{3}{4}$ of $\frac{2}{3}$ of 5s. 4d. + $\frac{1}{2}$ of 17s. 8d. + ·263 of £1 5s.
= 2$\frac{1}{2}$s. — $\frac{1}{2}$ of 64d. + 4s. 5d. + $\frac{263-26}{900}$ of 25s.
= 2s. 7$\frac{1}{2}$d. — 2s. 6d. + 4s. 5d. + $\frac{237}{900}$ of 1s.
= 4s. 6$\frac{1}{2}$d. + $\frac{7}{12}$ of 1s. = 4s. 6$\frac{1}{2}$d. + 6s. 7d. = 11s. 1$\frac{1}{2}$d.
Of £5, 11s. 1$\frac{1}{2}$d. = $\frac{11\frac{1}{2}}{100}$ = $\frac{23}{200}$ = ·11125. Ans.

4. Two men, A and B, with equal incomes, live in different towns, and are rated at 2s. 6d. and 2s. 2d. in the £ respectively, and the one pays £8 3s. 2d. more in rates than the other. Find their incomes.

Suppose A's income remains the same, but B's is altered so that he has to pay the same amount for rates as A does, although the rate in the £ is unchanged. What would B's income be then?

Since a difference of 4d. in the £ produces difference of £8 3s. 2d. on a certain income, that income must amount to as many pounds as £8 3s. 2d. contains fourpences.

$\frac{£8\ 3s.\ 2d.}{4d.}$ = $\frac{163s.\ 2d.}{4d.}$ = 489$\frac{1}{2}$

∴ Income of A and of B = £489 10s.

Then for B's rate to be raised by £8 3s. 2d., when he pays 2s. 2d. in the £, his income must be raised by as many pounds as the times £8 3s. 2d. contains 2s. 2d.

$\frac{£8\ 3s.\ 2d.}{2s.\ 2d.}$ = $\frac{163\frac{1}{2}}{2\frac{1}{6}}$ = $\frac{327}{13}$ = 75$\frac{1}{13}$

∴ B's increased income = £489 10s. + £75 6s. 1$\frac{1}{13}$d.
= £564 16s. 1$\frac{1}{13}$d. Ans.

Grammar.

BOYS AND GIRLS.

1. 'His *thoughts* I scan not; *but* I *ween*,
That, *could* their import *have been seen*,
The *meanest* groom in *all* the hall,
That e'er tied courser to a stall,
Would scarce have wished to be *their prey*,
For Lutterward and Fontenaye.'

Turn this passage into prose.

I do not pretend to know what he thought; but I feel sure his brooding was of such a nature that not even the lowest of the stable-servants would willingly have become a victim to his dark designs, could he have known them, no,—not though Lutterward and Fontenaye had been the reward.

2. Analyse the above passage, and parse the words in italics.

(*a*) His thoughts I scan not. Principal clause.

(*b*) [but] I ween. Principal clause, co-ordinate to (*a*) adversative.

(*c*) [that] the meanest groom in all the hall, would scarce have wished to be their prey, for Lutterward and Fontenaye. Noun clause, object to (*b*).

(*d*) could their import have been seen. Adverbial clause, denoting condition, modifying predicate of (*c*).

(*e*) that e'er tied courser to a stall. Adjective clause, attributive to subject of (*c*).

Connective.	Subject with attrib.	Predicate.	Object with attrib.	Extension of Predicate
(*a*)	I	scan	thoughts his	not
(*b*) but	I	ween	(clause *c*)	
(*c*) that	groom, the meanest in all the hall	would have wished	to be their prey	scarce (degree) for Lutterward and Fontenaye (reason)
(*d*) [if]	import their	could have been seen		
(*e*)	that	tied	courser	e'er (time) to a stall (place)

Thoughts—noun, abstract, plur. num., neu. gen., obj. case. gov. by 'scan.'

but—conjunction, disjunctive or adversative.

ween—verb, trans., indic. mood, pres. tense, 1st pers., sing. num., agr. with subject 'I.'

that—conjunction, subordinative.

could—verb, auxiliary of mood, denoting subj.

have—verb, auxiliary of tense, denoting perf.

been—verb, auxiliary of voice, denoting passive.

seen—passive participle of irreg. trans. verb 'see.'

could have been seen—verb, irreg., trans., passive voice, subj. mood, perf. tense, 3rd pers., sing. num., agr. with subject 'import.'

meanest—adjective of quality, superlative degree, attrib. to 'groom.'

all—adjective of quantity, attrib to 'hall.'

that—pronoun, relative, 3rd pers., sing. num., masc. gen., agreeing with antecedent 'groom,' nom. case, subject to 'tied.'

e'er—adverb of time, modifying verb 'tied.'

would—verb, aux. to 'have wished' indicating conditional form of tense.

have—verb, aux. to 'wished,' forming perf. tense.

wished—verb, reg., trans., past participle.

would have wished—verb, reg. trans., act. voice, indic. mood, past perf. tense (conditional), 3rd pers., sing. num., agr. with subject 'groom.'

scarce—adverb of degree, modifying verb 'wished.'

their—pronoun, pers., 3rd pers., plural num., neut. gen., agr. with 'thoughts,' poss. case, attrib. to 'prey.'

prey—noun, com., sing. num., neu. gen., nom. case, after intransitive verb 'to be.'

3. What is the force of these prefixes:—*be, for, mis, un, amphi, anti, cata, hemi*? Give words in which they occur, with their meaning.

be	makes transitive verb	bespeak = to speak for, or order.
	intensifies meaning	bestrew = to strew.
for	gives opposite meaning	forbid = to bid not, to prohibit.
mis	means, badly or wrongly	mistake = to take wrongly.
		mishap = something that happens badly.
un	to do the opposite	untie = to take out a knot.
	not (with adjectives)	unjust = not just.
amphi	both	amphibious = living on both land and water.
anti	against	Antipodes = having the feet opposed.
		anti-tobacconist = one opposed to the use of tobacco.
cata	down	catastrophe = a turning down, a disaster.
hemi	half	hemisphere = a half-globe.

Geography.

(Do *three* questions only.)

1. The circulation of air and water on the globe is greatly influenced by temperature. Explain and illustrate this.

The atmosphere which surrounds the earth, and the water which covers the largest part of its surface, are subject to varying but almost unceasing movements, termed, in the case of the atmosphere, winds, and, in the ocean, currents. These movements are largely affected by differences in temperature, that is, by varying degrees of heat. The effect of an increased temperature or greater warmth on both air and water, is to cause expansion or an increase of volume, and a lower temperature, on the contrary, causes, within certain limits, a decrease of volume. By the law of gravitation the lighter portions of any fluid mass rise to the top, while the heavier portions sink below; and further, in the nature of fluids there is a constant tendency to preserve or recover equilibrium, and so to equalize density over any surface.

These principles may be illustrated by the facts that the air in the neighbourhood of the equator becomes very hot through the great force of the sun's vertical rays; being thus heated the air expands, and thus being relatively lighter ascends, and flows in elevated currents over the heavier portions of the air to the north and south of the equator, while this mass of heavier air from the cooler parts of the earth forms currents flowing over the earth's surface from the neighbourhood of the poles towards the tropics. The direction of these currents is modified by the earth's rotation, and thus are produced winds which blow from the north-east and south-east, and are called the trade winds.

The land acquires heat and loses it again more readily than water, and the air over land and water surfaces is differently affected from this circumstance. Hence in a warm summer day we may feel at the seaside a cool breeze blowing from the slow-warming water to the quickly warmed land, and at night we find a wind blowing from the swift-cooling land to the slowly-cooled water. These are called land and sea breezes.

Currents in the sea are produced and influenced in a similar manner to that in which winds are produced and influenced; but the greater density of water and the interruptions arising from the disposition of masses of land constitute additional modifying circumstances. A current of cold water coming from the Antarctic Ocean, directed by the formation of the land, finds its way to the shore of Africa, and then across the Atlantic to the Gulf of Mexico. Here it is pent up long enough to become much warmer, and then forces its way at a considerable speed through the Channel of Florida, whence it flows with increasing breadth, but diminished velocity and warmth, towards the western countries of Europe, and is known as the Gulf Stream.

2. Describe the chief lakes or inland seas of Asia and Africa, stating any circumstances which make any of them important.

The chief lakes of Asia are the Caspian Sea, the Sea of Aral, the Dead Sea, Lake Balkash, and Lake Baikal. In all these but the last the water is very salt, and the loss by evaporation is greater than the supply of water by the rivers which flow into them. They fill portions of a great depression in the part of Asia to the west of the Altai Mountains and the great central table-land. Not one of the four has any outlet by which to communicate, as most large lakes do, with the ocean. The largest of all is the Caspian Sea, which occupies an area larger than that of the British Isles. Its surface is more than 80 feet below the sea level, and is gradually getting lower, owing to the excess of evaporation over the supply of water. The great River Volga, the Ural, and other large streams flow into it. Storms render its navigation difficult, and dangerous.

The Dead Sea is bordered by a desolate plain abounding in bitumen, and formerly the site of Sodom and Gomorrah. It receives the Jordan.

Lake Baikal is the largest body of fresh water in Asia. It lies to the south of the Yablonoi Mountains, and from it flows the Angora, a tributary of the Yenisei. A line of steamers plies along it, and it forms part of a great commercial route to China.

In the midst of Africa, north of the Equator, lies a large sheet of water, in some respects resembling the great Asiatic lakes. It is called Lake Chad, and though fed by several large rivers, its water does not find its way to the sea, but is either evaporated or filtered into the sand. Its area in the dry season is about 10,000 square miles, but in the wet season it is 40,000 or 50,000.

A great system of lakes more recently discovered and explored lies in the eastern part of Africa near the Equator. The largest of these is called Victoria Nyanza, having an area as large as Scotland. To the north-west of it is the Albert Nyanza. From these two lakes it has been proved by the explorations of Livingstone, Stanley, and other eminent travellers, the Nile issues. Further to the south lie Lake Tanganyika and Lake Nyassa, also associated with the names of Livingstone and Stanley. The great River Congo has its sources in or near these lakes. The lake district of East Central Africa is famous for the beauty of its scenery and its great fertility.

3. The rivers Congo, Nile, Irrawady, Obi. Trace briefly the course of these rivers, and say why they are remarkable.

The Congo rises in the highlands near the Lake Nyassa, and, flowing westward into Lake Bangweolo, issues thence and flows northward, crossing the Equator at about 20° E. longitude. It then makes a sweeping curve to the north-west, and bends to the south-west till it again crosses the Equator and flows into the Atlantic Ocean about 6° south latitude. It has received different names in different parts—the Chambesi, in its upper course, and the Lualaba in its middle portion, because it was not known until recently that these were parts of the same stream. Its basin is immense and remarkably well supplied with water. Draining tracts of country both north and south of the Equator, it is less subject to fluctuation with the seasons than many large rivers. Its navigation is interrupted by great falls about 140 miles from the sea. Its mouth is 6 miles broad, and its depth at mid-channel 150 fathoms. It is said that no other river, except the Amazon, discharges so large a volume of water.

The Nile rises in the Victoria Nyanza. From this lake it flows as a considerable stream to Albert Nyanza. Then it has a winding course and receives several tributaries before it reaches 10° north lat. It flows on generally northwards under the name White Nile till it reaches Khartoum, where it is joined by the Blue Nile from the Abyssinian Mountains. Another river from the same region, and called the Atbara, joins the main stream further north, and then for 1700 miles the Nile flows through Egypt to the Mediterranean Sea without receiving any other tributary. About 90 miles from the sea it separates into branches which include a marshy delta as large as Wales. Navigation is greatly hindered in its middle and upper courses by cataracts and rapids. Its volume is subject to remarkable variations. After the melting of the snows which feed its sources the lower part of its course is usually flooded, and it is to this swelling of the river that Egypt owes all its fertility, and occasional failures of the inundation cause great loss and distress. The length of the Nile is over 4,000 miles.

Two streams flowing from the high ground of Tibet to the north of the Himalayas unite to form the Irrawady. It flows eastward along the north side of the mountains, and turns south at their extremity. It then drains the western part of Further India, and flows into the Bay of Bengal through several mouths forming a large delta. It is navigable for about 300 miles from its mouth, and on its banks stand Ava and Mandalay, the old and new capitals of Burmah. Rangoon and Massein, two large ports, stand at its mouth. Its whole course is 1200 miles long.

The Obi rises in the Altai mountains, and flowing northwards drains Western Siberia. It receives the Irtish, Ishim, and Tobol, on the last of which stands Tobolsk the capital of Siberia. In the short summer these streams are navigable, and form means of communication and commerce. In the severe Siberian winters they are frozen over and form roads for sledges. The drainage of the Obi is greater than that of any other river in Asia. It enters the Arctic Ocean by a large opening called the Gulf of Obi. Its total length is about 2,000 miles.

4. Draw a map of China or of Asia Minor.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

GIRLS ONLY.

One hour allowed for this exercise.

Set in a triangular patch in flannel, about 3 inches each way, on it darn ten rows as for a thin place.

Arithmetic.

BOYS ONLY.

1. If a tradesman takes £11 4s. 3d. of ready money for a bill of £11 10s., what per cent. does he remit?

On £11$\frac{1}{2}$ the discount = £11 10s. — £11 4s. 3d. = 5s. 9d.
That is on 23 half sovereigns the dis. = 69 pence or 23 times 3d.
∴ On 10s. the discount is 3d. or $\frac{1}{10}$ or $2\frac{1}{2}$ %. Ans.

2. Find the square root of ·00012 to five decimal places, and show that $\sqrt{14\frac{2}{3}} = 3\cdot83$.

```
·000120 (·01095
   1
209  2000
   9  1881
2185  ·11900
      10925
        975
```

$\sqrt{14\frac{2}{3}} = \sqrt{\frac{44}{3}} = \frac{22}{6} = 3\cdot83$
·01095 +. Ans.

3. A invests a sum of money in the 3 per cents. at par, and B an equal sum in $4\frac{1}{2}$ per cent. debentures, and they receive the same dividend. Find the price of the debentures, brokerage being omitted.

£3 is produced by investing £100 in 3 per cents. at par.
Also £3 is produced by investing £100 in $4\frac{1}{2}$ % debentures,

∴ £$4\frac{1}{2}$ is produced by investing £100 × $\frac{4\frac{1}{2}}{3}$ = $\frac{£425}{3}$
= £141 13s. 4d. Ans.

4. If A can do a piece of work in 30 days, in what time will A, B, and C together do it, if A can do as much in 7 days as B in 8, and B as much in 5 days as C in 6?

Since A can do the work in 30 days, the part A does in one day = $\frac{1}{30}$.
Since B can do in 8 days what A does in 7, the part B does in 1 day is $\frac{7}{8}$ as much as A or $\frac{1}{30} \times \frac{7}{8}$.
And since C does in 6 days what B does in 5, the part C does in one day is $\frac{5}{6}$ as much as B or $\frac{1}{30} \times \frac{7}{8} \times \frac{5}{6}$.
∴ The part A, B, C together do in 1 day = $\frac{1}{30} + \frac{7}{240} + \frac{35}{1440}$
$= \frac{48 + 42 + 35}{1440} = \frac{125}{1440} = \frac{25}{288}$
And the number of days required = $1 \div \frac{25}{288} = \frac{288}{25} = 11\frac{13}{25}$.
$11\frac{13}{25}$ days. Ans.

History.

BOYS AND GIRLS.

1. Down to 1720, Charles, son of James I., James, son of Charles I., and Frederick, son of George II., are said to be the only sons of kings who ever had the freedom of the City conferred upon them. Tell briefly the subsequent fate of these three princes.

Charles, son of James I., succeeded his father as king of England in 1625. Before he had been long on the throne he tried to put into practice his ideas of absolute monarchy. His extravagant notions provoked the opposition of Parliament, and he endeavoured to rule without one. At last a civil war broke out in 1642, and many fierce battles ensued. At Naseby the king's party was hopelessly defeated in 1645. Soon after Charles became a prisoner, and after removing him from prison to prison his captors brought him to a kind of trial at Westminster. The result was practically a foregone conclusion. He was condemned to death, and on the 30th January, 1649, he was beheaded in the courtyard of Whitehall.

James, son of Charles I., was Duke of York. His elder brother Charles II. dying without lawful issue, James succeeded him in 1685. He foolishly attempted to establish a despotism, and claimed the power to modify the laws or dispense with them according to his pleasure. His wish to favour the Roman Catholics was probably the root of all his blunders. The people, however, would not put up with his doctrines nor with his attempts to put them in practice. They invited William of Orange who had married his daughter to come over to England. James fled from the country in fear, and in 1688 his daughter Mary and her husband were placed on the vacant throne. James never returned to England. He died in 1701 at St. Germains.

Frederick, son of George II., had a quarrel with his father which became more bitter after his marriage in 1737. In 1751 he died from the effects of a blow from a cricket ball. His son afterwards became George III. in 1760.

2. 'This' said Earl Granville, speaking of the Seven Years' War, upon his death bed, 'has been the most glorious war and the most triumphant peace that England ever knew.'

Support this opinion by a narrative of events.

The Seven Years' War lasted from 1756 to 1763. It sprang from the ambitious designs of the French with respect to portions of North America and India. In the former both French and English settlers had made homes and opened a trade with the natives. The French laid claim to exclusive possession of the valleys of the Mississippi and the lands bordering the St. Lawrence, and sought to prevent the English colonists from crossing the Alleghanies, and so from trading with the Indians. In 1756 the French made great preparations for war. They attacked Minorca with their fleet, and owing to an error of judgment on the part of the English Admiral Byng, the island fell into the hands of the French. In the early part of the war some other reverses befel the English. In India the French had been intriguing with some of the native rulers to gain superiority in that country, and had already obtained great influence in the Carnatic. But the energetic and decisive action of Clive resulted in the momentous victory of Plassey in June, 1757, by which English ascendancy was established and Bengal became a British possession. During 1758 places held by the French in Africa fell into English hands, and in North America possession was obtained of the whole of Cape Breton and Prince Edward's Island. The year 1759 was marked by three great victories for the English. On the Continent of Europe Frederick of Prussia, England's ally, had experienced reverses. Pitt sent to his aid 20,000 English troops, and by their dashing valour they entirely routed the French forces at Minden on the Weser. Pitt, the great Commoner, had planned the conquest of Canada in a masterly fashion. In pursuance of this, General Prideaux captured Fort Niagara; Amherst, with another division of the army, took Ticonderoga; and General Wolfe and the forces under his command succeeded in accomplishing the feat of capturing Quebec in spite of its almost impregnable position, the excellent preparations made by Montcalm, the French general, and the impossibility of obtaining the advantage of reinforcements from the troops of Amherst and Prideaux, as had been intended. Unfortunately, General Wolfe was killed in the action; but his skill and courage had greatly contributed to the victory which makes his fame undying. The result was the complete conquest of Canada. During this same year the French threatened an attack on the English coast, but the vigour of Pitt's administration of the war destroyed the hopes of his enemies. The Toulon fleet was defeated by Admiral Boscawen, and by the memorable victory of Admiral Hawke in Quiberon Bay the naval power of France was completely shattered. In 1760 the king, George II., died, and a lull occurred in the war. In 1761 the sovereigns of France, Spain and Naples formed the Family Compact. Pitt wished to re-enter on the war to forestall the

hostile action of the enemies of English supremacy. His advice was rejected, and he resigned. The war broke out again the next year, and several successes were gained in the West Indies, the Philippine Islands, and elsewhere. The new minister, Lord Bute, was however glad to seize an opportunity of making peace when it was sought by France and Spain. The Treaty of Paris was signed in February, 1763. It secured to the English most of her conquests in the West Indies, Senegal in Africa, Florida, Louisiana, Canada, Cape Breton, Nova Scotia, the North American fisheries, with the right of the French to share in the latter, the right to cut logwood in Honduras, and some other advantages. Havannah, the Philippines, Goree, and the French factories in the East Indies were restored. The seven years' war may justly be called glorious, and the peace of Paris triumphant for England, if we regard the victories gained and the possessions secured; but more especially when we consider how they established English supremacy in India and North America, and made firm the foundations of our great colonial empire.

3. Give some description of the new territories acquired by this country during the reign of our present sovereign, and of the circumstances under which we gained them.

During the reign of Queen Victoria, the following additions have been made to the British Empire:—Aden and Perim, Hong Kong and Kowloon, Scinde, the Punjaub, Nagpore and Oude, Pegu, Burmah, Labuan, Cyprus, New Zealand, Vancouver Island, the Fiji Islands, Natal, and British Caffraria, the Andaman and Nicobar Islands.

Aden, consisting of a town and the neighbouring land, forms a small peninsula, south of Arabia, near the entrance to the Red Sea. It was seized in 1839 on account of outrages by the Arabs. It is used as a coaling station.

Perim, is a small island in the Straits of Bab-el-Mandeb. It was taken in 1859 by order of the Governor of Aden, that a lighthouse might be built on it.

Hong Kong is a small island off the mouth of the Canton River, south-east of China. Its capital, Victoria, is the centre of a great trade. It was taken in 1841 during the Chinese war, and was ceded at its close in 1842.

Kowloon is a small peninsula on the coast opposite Hong Kong. It was ceded to the British in 1861 by the Emperor of China, on account of the depredations on the island of Hong Kong. Its inhabitants were chiefly pirates.

Scinde is a division of India lying on the west side, to the north of Bombay. It was annexed in 1843.

The Punjaub, or country of the five rivers, is in the north-west of India. It is drained by the tributaries of the Indus. It was annexed after the Sikh war in 1849.

Nagpore is a part of Central India. It was annexed on the death of its native ruler in 1853.

Oude is a large district north of the Ganges. It came into the hands of the East India Company in 1854.

Pegu, a part of further India, including the delta of the Irrawady, was annexed after the second Burmese war in 1852.

Burmah, an important part of the west of further India has been annexed so lately as 1885, as the result of its cruel king interfering with British traders.

Labuan in a small island in the China Sea, off the coast of Borneo. It was ceded to the British in 1847 by the Rajah of Bruni (Borneo), as a convenient station for putting down piracy, which prevailed largely in the neighbourhood.

Cyprus, is a large island in the eastern end of the Mediterranean Sea. It was acquired by agreement from the Sultan of Turkey in 1878.

New Zealand consists of two large islands, and a small one lying to the south-east of Australia. The area is considerably larger than that of Great Britain. High mountain ranges and many rivers are found in the large islands. The climate is much like that of England. New Zealand was discovered in the last century, but the first regular English settlement was made in 1839, and the Maori chiefs acknowledged British sovereignty in 1840.

Vancouver Island lies to the west of North America. It is very fertile, and is supplied with good harbours. It was settled in 1849, and united to British Columbia in 1866.

The Fiji Islands are a group of more than 200 islands in the Pacific Ocean. They came into possession of the English in 1874 by offer of the Fiji chiefs.

Natal was colonised in 1837. It was for some time treated as a province of Cape Colony, but in 1856 it was made a separate colony.

British Caffraria, another portion of South Africa to the north of Cape Colony, was acquired in 1853.

The Andaman Islands extend in a long chain in the Indian Ocean. They were occupied in 1856.

The Nicobar Islands, is a group to the south of the Andaman Islands. They were annexed in 1869.

Besides these, new colonies have been established by division of the older ones, as in the case of Victoria and Queensland, both separated from the older colonies in Australia, and practically formed into new countries.

Teaching.

Write out the notes of a lesson on 'British Exports.'

Introduce the lesson by directing attention to the advantages arising from commercial intercourse. Many countries lack some articles of food, clothing, etc., which they require, and at the same time produce more than enough of other commodities.

The British Isles are too densely peopled to be able to spare much of the produce of the soil. Of food materials they require more than they produce. But natural features and the character of the people are favourable for manufacturing industry. Hence our chief exports are manufactured goods. These general facts can be elicited from the class by questioning.

List of Exports:—Cotton goods, woollen goods, iron and hardware, linen, earthenware, glass, beer, silk, and chemicals. Some of the most important of these goods are made from raw materials imported from other countries. Why are these things brought to the British Isles to be made up? On account of the abundance of the coal and iron necessary, and the industry, enterprise, and skill, of the inhabitants. Also, we need to import food; so we must be prepared to make some suitable return. The children should be led by questions to understand this. Besides manufactured goods, we export coal, iron, salt, tin, copper, because these are produced in abundance.

Countries with which Britain trades:—United States, India, France, Australia, Germany, Holland, Russia, China, Belgium, Turkey, Brazil, Canada, South Africa, and New Zealand. These are our chief customers; but all countries that have any trade with civilised nations receive some of our exports.

The value of our exports is as much as £300,000,000 a year.

The chief British Ports:—In England—London, Liverpool, Bristol, Hull, Newcastle, Sunderland, Plymouth, Falmouth, Southampton, Shields.

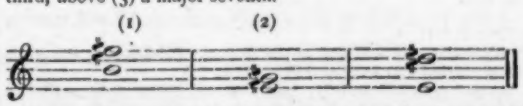
In Wales—Cardiff, Swansea, Holyhead.

In Scotland—Glasgow, Leith, Dundee, Greenock, Aberdeen, Dunfermline.

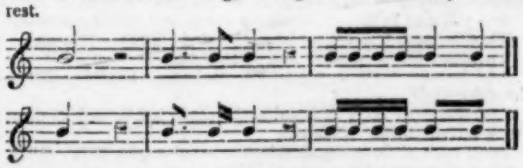
Music.

STAFF NOTATION.

1. Write above (1) a perfect or major fifth, above (2) a major third, above (3) a major seventh.



2. Re-write the following, halving the value of every note and rest.



3. State briefly the meaning of the following terms:—

(1) *Mezzo-piano.*	Moderately soft.
(2) *Grazioso.*	Graceful, smooth.
(3) *Allegretto.*	Rather lively, cheerful.
(4) *Forte.*	Loud.

TONIC SOL-FA.

1. Write a minor sixth above each of the following notes :—

(1) Above *soh*, *ma'*
(2) Above *ray*, *ta*
(3) Above *me*, *doh'*

2. Re-write the following, doubling the value of each note and rest :—

|s .,l :s | .s :d' | :m ‖
|s :-.l|s :— | :s |d' :— | :_ |m :— ‖

3. Same question and answer as in 3 in Staff Notation.

END OF FOURTH YEAR.

Three hours and a half allowed.

Euclid.

BOYS ONLY.

[All generally understood abbreviations or symbols for *words* may be used, but not symbols of operation, such as —, ×, +.]

(Answer two questions, including Question 3, if you can.)

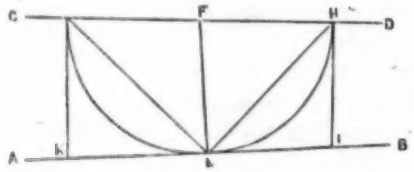
1. If a straight line be divided into two equal parts, and also into two unequal parts, the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Book II. Proposition 5.

2. To describe a square that shall be equal to a given rectilineal figure.

Book II. Proposition 14.

3. Given two straight lines not at right angles and a point in one of them; find two other points in the same, each equally distant from the given point and the other line.



Let AB, CD, be two given straight lines not at right angles to each other, and let F be a given point in AB. It is required to find in the line AB two other points each of which shall be equally distant from the given point E and from the given line CD.

At the point E draw EF at right angles to AB and meeting CD in F. (I. 11.)

With the centre F and at the distance FE describe the circle GEH cutting CD in G and H. (Post. 3.)

At the points G and H, draw GK and HI at right angles to CD and cutting AB in K and I. (I. 11.) K and I shall be the points required.

Join GE and HE.

Then because F is the centre of the circle GEH. (Const.)

Therefore GF is equal to EF. (Def. 15.)

And because GF is equal to EF, the angle EGF is equal to the angle GEF. (I. 5.)

Also the angle KGF is equal to the angle KEF, each of them being a right angle. (Const.)

From each of these equals take the equal angles EGF, GEF.

Then the remaining angle KGF equals the remaining angle KEG. (Ax. 3.)

Therefore the side KG is equal to the side KE. (I. 5.)

And in the line AB a point K has been found which is equally distant from the given point E and the given line CD.

In the same way it may be proved that the point I is another such point. Q.E.F.

Algebra.

(Answer two questions, including Question 3 if you can do so.)

1. By means of the identity $m^3 - n^3 = (m-n)(m^2+mn+n^2)$, show that $(ax+by)^3 - (bx+ay)^3 = (a^3-b^3)(x-y)\left(x^2+xy+y^2+\frac{3abxy}{a^2+ab+b^2}\right)$

Since $m^3 - n^3 = (m-n)(m^2+mn+n^2)$

Substitute $(ax+by)$ for m, and $(bx+ay)$ for n.

Then $(ax+by)^3 - (bx+ay)^3 = (ax+by-bx-ay)\left\{(ax+by)^2+(ax+by)(bx+ay)+(bx+ay)^2\right\}$

$= (a-b)(x-y)(a^2x^2+2abxy+b^2y^2+abx^2+a^2xy+b^2xy+aby^2+b^2x^2+2abxy+a^2y^2)$

$= (a-b)(x-y)\left\{x^2(a^2+ab+b^2)+xy(a^2+ab+b^2)+y^2(a^2+ab+b^2)+3abxy\right\}$

$= (a-b)(x-y)(a^2+ab+b^2)\left(x^2+xy+y^2+\frac{3abxy}{a^2+ab+b^2}\right)$

$= (a^3-b^3)(x-y)\left(x^3+xy+y^2+\frac{3abxy}{a^2+ab+b^3}\right)$

2. Find the G.C.M. of $2x^4-3x^3+2x^2-2x-3$, and $3x^4-4x^3-x-2$, and express the fraction whose numerator is the former and denominator the latter, in its lowest terms.

$$
\begin{array}{r|l}
 & 2x^4-3x^3+2x^2-2x-3 \\
 & 3 \\
\hline
3x^4-4x^3-x-2 & 6x^4-9x^3+6x^2-6x-9 \;(2 \\
 & 6x^4-8x^3\quad\quad -2x-4 \\
\hline
 & -x^3+6x^2-4x-5
\end{array}
$$

$$
\begin{array}{r|l}
 & -x^3+6x^2-4x-5 \\
 & -3 \\
\hline
3x^4-4x^3\quad\quad -x- 2 & -3x^4+18x^3-12x^2-15x \;(-3x-14 \\
 & 14x^3-12x^2-16x-2 \\
\hline
 & 14x^3-84x^2+56x+70 \\
\hline
 & 72x^2-72x-72 \\
 & x^2-x-1
\end{array}
$$

$$
\begin{array}{r|l}
 & x^2-x-1 \\
 & x+5 \\
\hline
-x^3+6x^2-4x-5 & -x^3+x^2+x \\
 & 5x^2-5x-5 \\
\hline
 & 5x^2-5x-5
\end{array}
$$

G.C.M. $= x^2-x-1$

And $\frac{2x^4-3x^3+2x^2-2x-3}{3x^4-4x^3-x-2} = \frac{(x^2-x-1)(2x^2-x+3)}{(x^2-x-1)(3x^2-x+2)}$

$= \frac{2x^2-x+3}{3x^2-x+2}$. Ans.

3. Show that if m, n be the roots of $x^2+px+q=0$; $m+n=-p$, and $mn=q$.

If m and n be roots of the given equation

$m^2+pm+q=0$

and $n^2+pn+q=0$

Hence $m^3-n^2+(m-n)p=0$

$\therefore m+n+p=0$

and $m+n=-p$.

Again $q=-m^2-pm$

$\therefore q=-m^2+(m+n)m=-m^2+m^2+mn$

That is $q=mn$.

Solve :— (1) $\left.\begin{array}{l}20x-23y=152\\19x-21y=141\end{array}\right\}$

(2) $\frac{3x}{x+2}-\frac{x-1}{6}=x-9$

(1) $20x-23y=152\ (a)$

$19x-21y=141\ (b)$

Subtract $\therefore\ x-2y=11\ (c)$

Multiply by 20 $\therefore 20x-40y=220$

Subtract from (a) $\therefore\ 17y=-68$

$\therefore\ y=-4$

Substituting in (c) $x=11+2y=11-8=3$

$x=3,\ y=-4$. Ans.

(2) $\frac{3x}{x+2} - \frac{x-1}{6} = x - 9$

Multiply by $6(x+2)$

$\therefore 18x - (x^2 + x - 2) = 6(x^2 - 7x - 18)$

$\therefore 18x - x^2 - x + 2 = 6x^2 - 42x - 108$

$\therefore 7x^2 - 59x = 110$

$$x^2 - \frac{59}{7}x + \left(\frac{59}{14}\right)^2 = \frac{110}{7} + \frac{3481}{196} = \frac{6561}{196}$$

$$\therefore \quad x - \frac{59}{14} = \pm\frac{81}{14}$$

$$\therefore \quad x = \frac{59 \pm 81}{14} = \frac{140}{14} \text{ or } \frac{-22}{14}$$

$\therefore$ $\underline{x = 10 \text{ or } -1\tfrac{4}{7}}$. Ans.

Mensuration.

(Answer *one* question.)

1. How much longer would it take a man to run round a square field whose side is 308 yards than round its inscribed circle, at the rate of 8 miles an hour?

Perimeter of square = 308 yds. × 4.

Circumference of inscribed circle = 308 × $3\frac{1}{7}$.

$\therefore$ Difference in yds. = $308 \times (4 - 3\frac{1}{7}) = 308 \times \frac{6}{7} = 44 \times 6$.

And since the rate of running is 8 miles, the difference of time required = $\frac{44 \times 6}{1760 \times 8}$ hr. = $\frac{1 \times 3 \times 60}{40 \times 4}$ min. = $\frac{9}{8} = 1\frac{1}{8}$ m.

$\underline{1\frac{1}{8} \text{ minutes}}$. Ans.

2. In the middle of a circular court whose diameter is 112 feet is a square whose side is 8 feet: find the cost of paving the remainder of the court at 1s. 9d. the square yard.

Area of court = $(11\frac{2}{3})^2 \times 3\frac{1}{7} = 56^2 \times \frac{22}{7}$

= $448 \times 22 = 9856$ sq. ft.

Area of square = $8^2 = 64$ sq. ft.

Portion to be paved = 9856 − 64 = 9792 sq. ft. = 1088 sq. yds.

Cost of paving = 1s. 9d. × 1088 = 1088s. + 816s.

= 1904s. = $\underline{£95\ 4s.}$ Ans.

Arithmetic.

GIRLS ONLY.

1. Define—Interest, discount, stock, average, present worth, brokerage, and bill of exchange.

Show clearly, with an example, the difference between simple and compound interest, and that between true and banker's discount.

Interest is a sum of money paid for the use of money. It is usually reckoned at a certain rate per £100, or so much per cent.

Discount is an allowance made by the receiver of money if it is paid before it is actually due. This also is reckoned usually at so much per cent.

Stock is money lent to the Government of a country or to some public company or corporation to carry on its business. It forms a capital sum on which interest is paid to the lenders, or to those who represent the lenders.

Average is the result that would be produced if a series of unequal numbers or quantities were equally divided or distributed.

Present Worth is the sum which should be paid now as the equivalent of a larger sum to be paid at some future time, that is, it represents a debt diminished by the discount allowed for present payment.

A Bill of Exchange is a business document which requests the person on whom it is drawn to pay money for value received within a certain time to some other person named in the bill.

The difference between Simple and Compound Interest may be thus explained. If a person borrows a sum say of £600 for three years at 5 per cent. per annum simple interest, he would be able to free himself from the debt at the end of the 3 years by paying the £600, called the principal, together with a sum of £30 for each of the 3 years, that is, a sum altogether of £690. If, however, he undertook to pay 5 per cent. compound interest, he would have to pay for the first year £30, for the second £31 10s., that is the 20th part of £630, and for the third year £33 1s. 6d., that is, the 20th part of £661 10s. The total repayment would thus amount to £694 11s. 6d., or £4 11s. 6d. more than in the case of simple interest. Thus it will be seen that in reckoning compound interest, the interest for one year is added to the previous capital or principal to form the capital on which the next year's interest is to be calculated, and this goes on until the last year of the period for which interest has to be reckoned.

True Discount is the sum which should be deducted from an amount payable at some future time so as to leave a sum which if lent out at the specified rate of interest would amount in the specified time to exactly the sum payable at that time. It is the custom of bankers, however, in discounting bills before they are due, to accommodate their customers, to deduct simple interest on the amount of the bill. This gives them an advantage equal to the interest on the difference between the full amount of the bill and the true present worth of it.

For example, if a banker agrees to discount a bill of £82 due six months hence at 5 % per annum, he will deduct for the six months $2\frac{1}{2}$ % or $\frac{1}{40}$ of the whole amount, that is £2 1s., and will pay only £79 19s. for the bill. But if true discount were reckoned it would be $\frac{1}{41}$ of the amount, that is, £2, and the sum paid as present worth would be £80. It is evident that in six months £80 would amount to £82 at the given rate, and £79 19s. would not quite amount to the same. In the supposed case the difference amounts to 1s.

2. Which would be the more advantageous for a shopkeeper whose business pays at the rate of 4 per cent. per annum, to accept in six months' time the sum of £362 10s. as payment of an account now due, or £350 ready money? How much more would he receive by accepting the more advantageous terms?

The interest on £350 for 6 months at 4 % per annum

$$= \frac{£350}{100} \times \frac{1}{2} = £7$$

And the amount of £350 in 6 months would be £357.

Hence the receipt of £362 10s. in 6 months would be the more advantageous for the shopkeeper, and he would benefit by that plan to the amount of $\underline{£5\ 10s.}$ Ans.

3. The difference between the annual amount received from investing a certain sum in Six per Cent. Stock at 126, and Nine per Cent. Stock at 210 is £22 10s. What amount is invested?

The Interest received from an investment in 6 per Cents. at 126 is $\frac{6}{126}$ or $\frac{1}{21}$ part of the amount invested.

The Interest on an investment in 9 per Cents. at 210 is $\frac{9}{210}$ or $\frac{3}{70}$ of the amount invested.

The difference in these two results represented fractionally

$= \frac{1}{21} - \frac{3}{70} = \frac{10 - 9}{210} = \frac{1}{210}$ of the amount invested.

$\therefore$ The amount invested = the diff. of interests × 210

= £22 10s. × 210 = $\underline{£4725}$. Ans.

4. What sum must a man invest is Six per Cents. at $64\frac{1}{2}$ in order to have a clear income of £349 15s. 10d., after paying an income tax of 10d. in the pound?

Income tax of 10d. in £ = $\frac{10}{240} = \frac{1}{24}$ of gross income.

= $\frac{10}{230}$ or $\frac{1}{23}$ of net income.

$\therefore$ Net income of £349 15s. 10d. represents gross income of £349 15s. 10d. + $\frac{1}{23}$ of £349 15s. 10d. = £349 15s. 10d. + £15 4s. 2d. = £365.

Interest = $\frac{6}{64\frac{1}{2}} = \frac{12}{129} = \frac{4}{43}$ of amount invested.

Since $\frac{4}{43}$ of investment = £365

$\frac{1}{43}$ " = £$\frac{365}{4}$ = £91 5s.

and $\frac{43}{43}$ or the whole " = £91 5s. × 43

= $\underline{£3923\ 15s.}$ Ans.

Grammar.

BOYS AND GIRLS.

1. 'Twas *now* a *place* of punishment;
Whence if *so* loud a shriek *were sent*,
As reached the upper air,
The hearers blessed *themselves* and said,
The *spirits* of the sinful *dead*,
Bemoaned *their* torments there.

Analyse this passage and parse the words in italics.

a. 'Twas now a place of punishment. Principal clause.

b. Whence if so loud a shriek were sent. Subordinate clause to *a*. Adverbial of Condition.

c. As reached the upper air. Subordinate clause, Adjective, attributive to 'shriek' in *b*.

d. The hearers blessed themselves. Principal clause. Co-ordinate to *a*.

e. And (they) said. Principal clause. Co-ordinate to *a* and *b*.

f. The spirits of the sinful dead
Bemoaned their torments there. Subordinate clause, Noun, Object to 'said' in *e*.

	Connective.	Subject with Enlargements.	Predicate.	Object with Enlargements.	Exten. of Predicate.
a		It	was a place of punishment		
b	if	a shriek so loud	were sent		whence (*Place*)
c		as	reached	the upper air	
d		the hearers	blessed	themselves	
e	and	(they)	said	(clause *f*)	
f		The spirits of the sinful dead	bemoaned	their torments	there (*Place*)

Twas=It was.

It—Pronoun, personal, 3rd pers., sing. num., neut. gend., nom. case, subject to 'was.'

twas—verb, irreg. intrans., indic. md., past tense, 3rd pers., sing. num., agreeing with subject 'it.'

now—adverb of time, modifying verb 'was.'

whence—adverb of place, modifying 'were sent.'

so—adverb of degree, modifying adj. 'loud.'

were—verb, irreg. intrans., aux. of passive voice.

sent—verb, irreg. trans., pass. participle of 'to send.'

were sent—verb, irreg. trans., passive voice, subjunctive md., past tense, 3rd per.. sing. num., agreeing with subject 'shriek.'

as—pronoun, relative, 3rd pers., sing. num., neut. gen., nom. case., subject to verb 'reached.'
(If 'as' be resolved into 'that it,' 'that' is a conjunction correlative to 'so,' and 'it' a personal pronoun subj. to 'reached.')

themselves—pronoun, compound personal (reflexive), 3rd pers., plur. num., com. gend., objective case, gov. by trans. verb 'blessed.'

spirits—noun, com., plur. num., neut. gend., nom. case, subject to verb 'bemoaned.'

dead—adj. used as noun, com., 3rd pers., plur. num., neut. gend., objective case, gov. by preposition 'of.'

their—pronoun, pers., 3rd pers., plur. num., neut. gend., possessive case, attributive to torments.

2. From what Latin roots are the following words derived:—Library, locomotion, eloquence, elucidate, legitimate, lunatic, extravagant.

Library is derived from *liber*, a book. The affix *ary* is added and the word means a place for books.

Locomotion from *locus*, a place, and *moveo*, I move, *motio*, movement, *tion* is an affix forming an abstract noun.

Eloquence is from *loquor*, I speak, *loquens* speaking. The prefix *e* means out, and *ence* is a noun affix.

Elucidate is from *lux*, light, the noun, whence *lucidus*, light or clear, the adjective. E is a form of the prefix *ex*, out, and *ate* is a verb affix.

Legitimate is from the Latin noun *lex*, law, adjective *legitimus*, lawful, and *ate*, a verb affix.

Lunatic from *Luna*, the moon, and the adjective affix *tic*.

Extravagant from *extra*, beyond, and *vagor*, I wander, *vagans*, wandering; *ant* is an adjective affix.

3. When did the following writers live, and what are their principal works:—Spenser, Pope, Milton, Locke, Bacon, Chaucer?

Geoffrey Chaucer, the earliest of these writers, lived from about 1340 to 1400. His most important works were 'The Canterbury Tales,' and 'The Romaunt of the Rose.'

Edmund Spenser flourished in the reign of Queen Elizabeth. He was born in 1553 and died in 1599. His chief poem is 'The Faerie Queen.'

Francis, Lord Bacon, was born in 1561 and died in 1626. His most famous works are the 'Novum Organum,' 'The Advancement of Learning,' and his Essays.

John Milton lived from 1608 to 1674. His chief works are 'Paradise Lost,' 'Paradise Regained,' 'Samson Agonistes,' 'Lycidas.'

John Locke, a philosophical writer, was born in 1632 and died in 1704. He is best known for his 'Essay concerning the Human Understanding,' and his 'Thoughts on Education,' and 'Letters on Toleration.'

Alexander Pope was born in 1688 and died in 1744. His best known works are the 'Essay on Man,' 'Essay on Criticism,' The 'Rape of the Lock,' Letters, and Translation of Homer.

Geography.

(Do three questions only.)

1. At Naples, on the 1st of January, the clocks were 50 minutes in advance of those in London; the daylight lasted an hour longer, and the temperature was 20 degrees warmer. Account as fully as you can for this.

The difference of time is explained by the difference of longitude. Naples being east of London, the sun reaches the meridian of Naples before that of London. The longitude is about 14½°. As every degree represents 4 minutes the Naples time should be 58 minutes before London time.

Daylight lasts longer at Naples than London, because it is nearer the equator, and therefore the sun is for a longer time above the horizon. In the winter the period of daylight in London is about 8 hours out of 24, while at Naples it is about 9 hours.

The difference of latitude, which is as much as 10 degrees, also accounts for the warmer temperature of Naples as compared with London. The explanation of this is that the nearer a place is to the tropics the more directly do the sun's rays strike upon it, and therefore the amount of heat received is greater. At corresponding times in the year, the sun will always rise higher at noonday in Naples than it does in London.

2. The height of the tides will vary at different times and at different places. Explain and illustrate this.

The tides are periodical risings and fallings in the surface of the water which covers so large a part of the earth's surface. These regular movements are caused chiefly by the attraction of the moon. For the water owing to its liquid nature is acted upon more easily by the moon's attraction, and is drawn, so to speak, away from the earth, and swells up on the side which is under the influence of the moon, and as the force of this attraction is greater on the main body of the earth than on the water on the further surface, there is a swelling of the water there also. Thus there are two high tides on opposite portions of the earth's surface, and they succeed each other at intervals of about 12½ hours. But though the moon is the chief agent in producing the tides, the sun also has considerable influence, and the variation in the height of the tides at the same place at different times is due to this. When the sun's influence acts in the same direction as the moon's, that is, at the time of new moon and full moon, the tides are higher and are called spring tides; when the sun's force is exerted at right angles to that of the moon, the effect of the latter is diminished, and low or neap tides are caused. This happens at the time when the moon is in her first and third quarter.

The variations in the height of the tides at different places are very marked. They arise chiefly from the conformation of the land masses, and the nature of the sea-bed. If the waters of the earth covered its surface to an equal depth everywhere the tides would be perfectly uniform in succession and in height. But every island and every mass of land interferes with this regularity. In the great extent of ocean to the South of Asia, Africa and America, the principal tidal wave is formed because there is the least land to interfere with it. This wave in its progress finds its way into bays and openings. Where the bays narrow rapidly, or grow shallow, the rise of tide becomes more remarkable. This is the case in the Bay of Fundy on the coast of North America, in the neighbourhood of Calcutta, at the Mouth of the Amazon, and at the Mouth of the Severn. The extraordinary rise of water at the mouth of certain rivers is called the Tidal Bore, and is partly due to the narrowing of the channel up which the tidal wave comes, partly by the conflict with the outward current, and partly, as is the case in the Severn, by the decreasing depth. The tide in the Pacific rises only about 2 feet, in the Bay of Fundy it rises 40 or 50 feet. In the Mediterranean, which has a narrow entrance, through which the tidal wave can exert little influence, the tides are very slight.

3. The latitude of a place, the seas, the mountains, the plains, the deserts, or the forests surrounding it may all influence the climate. Show how this may be, and give illustrations.

The nearer a place is to the equator, the more directly do the sun's rays fall upon it, and the more intense is their effect. Hence the latitude of a place, which is the measure of its distance from the equator, is the primary element in determining its climate. Thus, the South of Europe is much warmer than Central Europe because it is nearer the equator, and for a similar reason Southern India is warmer still.

The proximity of the sea usually has a moderating effect on the climate of a place. This arises from the fact that water is more slowly heated and cooled than land, and therefore is not subject to such great extremes of temperature. Air over the surface of the sea is kept moist, and partakes of the temperature of the sea, and then communicates some of this influence to the neighbouring land by the action of sea-breezes. It is for this reason that the British Isles have a climate so much more equable than that of Central Europe in the same latitude, and also that many of the Pacific Islands enjoy a delightfully mild climate even within or near the tropics.

Mountains have a considerable influence on the climate of countries. They serve sometimes to ward off cold winds, sometimes warm ones. Thus the Himalayas keep the cold blasts from Siberia from the plains of Hindostan, and also prevent the warm breezes of the south from reaching Central Asia until after they have been cooled by crossing the snowy ridge. In some cases mountains seem to extract all the moisture from winds blowing from the sea and cause the opposite side to be almost rainless. This happens in Chili, on the west of the Andes.

Plains usually cause temperature to be low, partly perhaps from the nature of the soil, and partly from the land having no shield against the winds which sweep over the surface. The great plain of Europe, and that of Siberia illustrate this fact.

Deserts consisting of sandy and rocky wastes are usually very hot, and cause the surrounding countries to have a hot climate. The want of moisture causes the surface to become quickly and intensely heated. North Africa affords examples of countries suffering from tropical heat without being within the tropics, the cause being the hot winds from the desert of Sahara.

Forests cause a country to be more moist, probably by preventing evaporation, and by contributing elements to the soil which render it more absorbent or spongelike. They also serve to temper the direct action of the sun's rays on the land, and to keep off sharp winds. The valley of the Po used to be well-wooded. The cutting down of its forests has laid it open to the scorching sirocco from the south. Alsace has suffered from the removal of the forests of the Vosges, which used to hinder the eastern blasts. Planting forests has been found to improve climate and make a land more fertile as in the south of France.

4. Draw a map of the Mediterranean or the Gulf of Mexico.

SECOND PAPER.

(Two hours and a half allowed.)

Needlework.

GIRLS ONLY.

(One hour allowed for this exercise.)

Join two pieces of calico half their length, and insert a gusset, as for the body of a shirt, and stitch it across. Also work at least two inches of coral stitch, and mark a figure 5.

Arithmetic.

BOYS ONLY.

1. Find in money the value of ·428571 of ·6 of a guinea + 3·0875 of £2 10s. — $\frac{3}{8}$ of $1\frac{3}{4}$ of 3d.

·428571 of ·6 of 21s. + 3·0875 of 50s. — $\frac{3}{8}$ of $1\frac{3}{4}$ of 3d.
= $\frac{3}{7}$ of $\frac{3}{5}$ of 21s. + $3\frac{7}{80}$ of 50s. — $\frac{3}{8}$ of $\frac{7}{4}$ of 3d.
= $\frac{9}{35}$ of 21s. + $30\frac{7}{8}$ of 5s. — $\frac{21}{32}$ of 1d.
= 6s. + £7 10s. + 4s. $4\frac{1}{2}$d. — $1\frac{5}{32}$d.
= £8 0s. $4\frac{1}{2}$d. — $1\frac{5}{32}$d. = £8 0s. $3\frac{27}{32}$d. Ans.

2. If a grocer by selling tea at 3s. per lb. gains $12\frac{1}{2}$ per cent., what did the tea cost him per cwt.?

What cost £100 is sold for £$112\frac{1}{2}$
Or what cost 8 is sold for 9
∴ the cost price is $\frac{8}{9}$ of the selling price
And 1 lb. cost $\frac{8}{9}$ of 3s. or 2s. 8d.
112 lbs. at 2s. 8d. = 112 times 2s. 6d. + 112 times 2d.
= £14 18s. 8d. Ans.

3. If I owe a bill of £350 10s. payable six months hence, what ought I to pay if the money is not paid till eight months hence, interest at the rate of $4\frac{1}{2}$ per cent. per annum being charged for the extra time?

The extra time is 2 months, and the interest °/₀ for this time = $\frac{4\frac{1}{2}}{6} = \frac{3}{4}$ = 15s.

Interest on £350 10s. at 15s. °/₀ = £2 12s. 6d. + $\frac{3}{80}$ of 10s.
= £2 12s. 6d. + $\frac{3}{8}$s. = £2 12s. $6\frac{3}{10}$d.
Amount payable = £350 10s. + £2 12s. $6\frac{3}{10}$d.
= £353 2s. $6\frac{3}{10}$d. Ans.

A man invests £2000 as follows:—£600 in $4\frac{1}{2}$ per cent. railway debentures at 125; £500 in the three per cents. at par., the remainder on interest at $3\frac{1}{2}$ per cent. Find the average rate of interest which he gets for the whole.

Per centage on the debentures = $\frac{4\frac{1}{2}}{125}$ of $4\frac{1}{2} = \frac{4}{5}$ of $\frac{9}{2} = \frac{18}{5} = 3\frac{3}{5}$.
Total interest = $(3\frac{3}{5} \times 6) + (3 \times 5) + (3\frac{1}{2} \times 9) = 21\frac{3}{5} + 15 + 31\frac{1}{2} = £68\frac{1}{10}$.
Average rate of interest = $68\frac{1}{10} \div 20 = 3\frac{41}{1000}$. Ans.

History.

BOYS AND GIRLS.

(Answer *two* questions.)

1. 'The Norman and Lancaster dynasties each lasted about seventy years; from the last rising of the Stuarts to the fall of Napoleon was just seventy years; and it was not so long from the accession of Charles I. to the Great Revolution.' Show the accuracy of this statement, with dates of leading events.

The Norman line, excluding Stephen of Blois, ruled England from 1066 to 1135, or 69 years. The House of Lancaster lasted from 1399 to 1461, or 62 years. The last rising of the Stuarts was the Rebellion of 1745, and Napoleon's fall at Waterloo took place in 1815 just 70 years later. Charles I. came to the throne in 1625, and the Great Revolution occurred in 1688, or 63 years after.

The following were the leading events in each of these periods:—

Norman Rule.—
Completion of the conquest, 1071.
Compilation of Domesday Book, 1086.
Death of the Conqueror and accession of Rufus, 1087.
Quarrel of Rufus with Anselm and the clergy, 1093.
Beginning of the Crusades, 1096.
Death of the Red King, and Accession of Henry I., 1100.
English Conquest of Normandy, 1106.
Death of Prince William in Wreck of White Ship, 1120.
Death of Henry I., 1135.

Lancastrian Period—
Accession of Henry IV., 1399.
Revolt of Percies and Battle of Shrewsbury, 1403.
Accession of Henry V., 1413.
Battle of Agincourt, 1415.
Treaty of Troyes, 1420.
Death of Henry V., and Accession of Henry VI., 1422.
Battle of Verneuil, 1424.
Siege of Orleans, 1429.
Death of Joan of Arc, 1431.
Cade's Insurrection, 1450.
Outbreak of War of the Roses, 1st Battle of St. Alban's, 1455.
Battle of Wakefield, 1460.
Second Battle of St. Alban's, 1461.
Total defeat of the Lancastrians at Towton, 1461.

Stuart Period—Charles I. to end of James I.—
Accession of Charles I., 1625.
Petition of Right, 1628.
Puritan Emigration to New England, 1630.
Hampden refuses to pay Ship Money, 1637.
Meeting of Long Parliament, 1640.
Outbreak of Civil War, 1642.
Battle of Marston Moor, 1644.
Battle of Naseby, 1645.
Execution of Charles I., 1649.
Cromwell Protector, 1654—1658.
Restoration of Charles II., 1660.
Act of Uniformity and similar Acts, 1661—1665.
Great Plague and Fire of London, 1665—6.
Peace of Breda, 1667.
The Test Act, 1673.
Habeas Corpus Act, 1679.
Death of Charles II. and Accession of James II., 1685.
Monmouth's Rebellion and Battle of Sedgemoor, 1685.
Trial of the Seven Bishops, 1688.
Abdication of James II., and Landing of William, Prince of Orange, 1688.

The '45 to Waterloo—
Battle of Culloden, 1746.
Peace of Aix-la-Chapelle, 1748.
The Seven Years' War, 1756—1763.
Accession of George III., 1760.
Warren Hastings, Governor-General of India, 1773.
Declaration of Independence (America), 1776.
Trial of Hastings, 1786.
French Revolution, 1789.
Irish Revolt, 1795—98.
Act of Union with Ireland, 1800.
Peace of Amiens, 1802.
War declared by Napoleon, 1803.
Battle of Trafalgar, 1805.
Second War with America, 1812.
Battle of Waterloo and Treaty of Paris, 1815.

2. 'The Seven Years' War gave England the control of the seas and the mastery of North America and India, made her the first of commercial nations, and prepared that vast colonial system which has planted new Englands in every quarter of the globe.' Briefly relate the chief successes of this war at sea, and in Asia and America, and the Colonies.

The chief successes of the English at sea in this war, were the following:—The forts of Cherbourg were destroyed in 1758, and in July, 1759, Havre was bombarded by Admiral Rodney. Soon afterwards, Admiral Boscawen dispersed the Toulon fleet in Lagos Bay, on the south of Portugal; and in November of the same year, Admiral Hawke gained the great naval victory of Quiberon Bay, in the north of the Bay of Biscay—a victory in which the French fleet was completely shattered.

In 1761 Admiral Keppel captured Belle Isle, off the coast of Brittany, and in 1762 Havana, on the north-west of Cuba, was besieged and taken from Spain; Manilla, in the Phillipines, was bombarded and captured, and several of the West Indian Islands were also taken. The result of all these victories of the English fleet was to establish our naval supremacy.

The chief English successes in India were gained by the energy and daring of Robert Clive, a young officer in the East India Company's service. In 1756 Fort Hooghly, and some other forts near Calcutta were taken; in May, 1757, Chandernagore was captured, and rather later in the same year, Clive gained the splendid victory of Plassey, by which the power of Surajah Dowlah was broken, and this led to the establishment of English dominion over the Carnatic, a district which had hitherto been largely under French influence.

In North America, the capture of Louisburg, in Cape Breton, brought that island into English possession in 1758, and shortly afterwards Forts Frontenac and Duquesne were taken. Then Generals Amherst and Johnson took Ticonderago and Fort Niagara from the French, and General Wolfe with remarkable skill and daring stormed Quebec, which occupied a position on the St. Lawrence considered impregnable. This happened in 1759, and though the marvellous young General died in the hour of victory, his success secured for him undying fame. Montreal and other places surrendered to General Amherst in 1760, and Canada passed completely into British possession.

In the Colonies, chiefly those of North America and the West Indies, the results of the Seven Years' War were to secure the rights of the fisheries, and to securely establish the colonists under English rule. By the Treaty of Paris signed in 1763, guarantees were given against such injuries has had sprung from previous disputes between the rival nations. There remained freedom of development in the direction away from the sea-board, freedom of which advantage has been taken freely and is still taken by the ever-spreading branches of the British stock.

3. How does a man become a member of the House of Commons? Describe the rights and privileges of that House, and tell in what its power consists.

In order that a man may become a member of the House of Commons, he must first make himself known to the electors in one of the numerous constituencies in Great Britain or Ireland, which have the power to elect representatives. If his opinions and abilities commend him to some of these electors, he may secure at the time of an election that he will be nominated as a candidate. When this is done, and probably before also, he and his friends canvass the electors, that is, visit them with a view to obtain promises of support. To help this business forward, the candidate usually addresses public meetings and issues printed addresses to explain and defend his views on public questions. Then on an appointed day, the electors give their votes between certain fixed hours. This they do by ballot,—that is, by marking papers to indicate which candidate they prefer and placing them unsigned in a box, from which all the papers are afterwards taken and sorted. and the candidate preferred by the greatest number of voters is declared elected. When Parliament meets, he then goes to the House, takes the oath of allegiance, and is admitted a member.

The House of Commons has the power to assist in making new laws, in repealing or amending existing laws. In practice too it decides who shall be the responsible advisers of the Sovereign, that is really, who shall govern the country, and on what principles it shall be governed. The root of this power lies in the fact that all money required for purposes of government can only be raised in the form of taxation by the will of the House of Commons. If any government authority should seek to carry out its desires contrary to the will of the representatives of the people, the latter could refuse to provide the means to carry on the government. This it is which makes it true to say that, with such limitations as the laws of nature impose, Parliament is omnipotent. This is practically true, though the Sovereign has the right to dissolve Parliament at any time, and the House of Lords, sitting by hereditary right, has the power to veto any act of the Commons. For the power of stopping the supplies would ultimately secure the acquiescence of the other estates of the realm in the will of the Commons. Individual members have the privilege of being free from liability to arrest for debt, etc., during the session and for some days before and after. By the present law no Parliament can last longer than seven years without a fresh election. As a matter of fact no Parliament in recent times has lasted so long. Parliament has the power to alter or repeal the rules by which it is governed.

Teaching.

Write out the notes of a lesson on *Dress*.

1. *What is dress?* A covering for the body.

2. *What are the objects of dress?* First, to protect the body from the effects of climate—from cold, from heat. Second, for decency. Third, for ornament. Explain and elicit how differences in climate determine differences in the kind and amount of dress. However mild the climate may be, some kind of dress is worn; though people very low in the scale of civilisation seem sometimes to use it mostly for the purpose of ornament or show. Instance some African tribes.

3. *What are the various kinds of dress?* In very warm countries dress consists mostly of light textile fabrics made of cotton or linen. In very cold countries, skins of animals, and furs are used, because these prevent the escape of the natural heat of the body. In temperate and changeable climates various materials are used, linen and cotton, silk and wool, with skins and furs for ornament, or for very cold weather. In most countries the feet are protected by substantial coverings of leather called boots and shoes. Why? to guard against wet, and injuries from stones, etc.

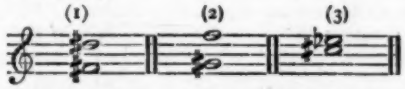
4. *Whence are materials obtained?* Vegetable fibres—cotton and linen; Animal products—wool, silk, furs, leather. Cotton abounds in America and India; flax, from which linen is made, in Ireland, Holland, Russia; wool is produced in England, Saxony, Spain, Australia; silk, from the silkworm, in France, Italy, China, India. Leather is made from the skins of animals obtained largely from Russia, Brazil, Australia, New Zealand. Furs from America, Russia, Siberia.

5. *What rules should regulate our dress?* First, let the dress be healthy—suited to the climate—suited to our own constitution. For instance, flannel or woollen clothing should be worn by people whose chests are delicate, or who are apt to catch cold. Second, dress should be reasonable in cost. There is nothing in which it is easier to be extravagant. Extravagance is foolish, for costly dresses are not always best looking, and those of moderate cost are more generally useful. Third, avoid extremes of fashion. Dress should not make a person look conspicuous. Cheerfulness in colour and style are reasonable, but not gaudiness or oddness. Fourth, be careful with dress—careful to avoid tearing and spoiling dresses—careful to keep them clean and neat. Refer to the words of Shakespeare. 'The apparel oft proclaims the man.' Hamlet, Act I, Scene III.

Music.

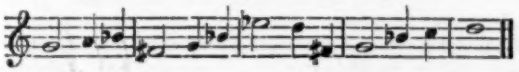
STAFF NOTATION.

1. Write below each of the following intervals its name (major second, &c.)



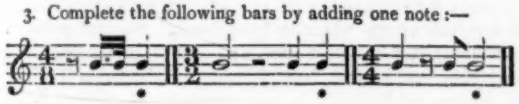
Major sixth. Diminished Seventh. Diminished Third.

2. In what minor key is the following passage?



In G minor.

3. Complete the following bars by adding one note:—



TONIC SOL-FA.

1. Write the names of the following intervals:—

(1) *d* to *lah*. (2) *se* to *fah* (3) *de* to *sa*

Minor sixth. Diminished seventh. Diminished third.

2. In the minor or *Lah* mode (1) what is the major or essential seventh, and (2) what is the minor or essential sixth?

(1) *se*. (2) *fah*.

3. Write in figures over each note and rest of the following passage its value in pulses or fractions of a pulse.

1½ ½ ½ ½ ½ ½ ¾ ¼ 1

| s :-. l | s . f : . m | r . f : m ||

—o—

Lectures on Shakspere's 'King Lear.'

BY H. MARMADUKE HEWITT, M.A., LL.M.,

Late Assistant-Examiner in the University of London.

From Act I., Sc. 4, line 281, to the end of the First Act; and two Scenes of Act II.

IN the last lecture we suggested that '*you were best take my coxcomb*' (Sc. 4, line 94) was a form of expression caused by a confusion of two constructions. We do not mean, however, that the words as they stand are unintelligible. The meaning will be tolerably clear if we consider the whole passage as equivalent to '*for* you *it* were best *to* take my coxcomb,' parsing *you* as the indirect object or 'dative,' and regarding *were* as = 'would be.'

We will now make haste to finish the First Act, of which we have still one whole scene remaining, besides some sixty lines of Scene 4. We shall therefore arrange certain extracts, as before, in tabular form:—

Line 291, *untented woundings*	incurable stabs. (A tent was a roll of lint used in probing and purifying deep wounds.)
„ 294, *the waters that you lose*	the tears you shed.
„ 297, *kind and comfortable*	kind and comforting. (Compare the 'comfortable words' of the Church of England Communion Office, and also Act II., Sc. 2, line 160.)
„ 315, 6, *keep at point*	maintain all in readiness, or fully armed.
„ 322, *still*	ever.
„ 329, *take some company*	take some companions.
„ 330, *inform her of my particular fear*	tell her how I, for one, am afraid of our father.
„ 336, *attasked*	taken to task, censured.
„ 341, *the event*	the event will show, or await the event (an elliptical expression).

Scene 5.

Line 3, *her demand out of the letter*	the questions she will put after receiving the letter.
„ 10, 11, *thy wit shall not go slipshod*	'Thy wit' (emphasis on *thy*) 'need not protect itself by wearing slippers' (because you have none).
„ 13, 14, *thy other daughter will use thee kindly*	thy other daughter will use thee according to her nature.
„ 37, *to take't again perforce*	would it be best to take it back by force? (By *it* is meant either the kingdom, which Lear had hastily resigned, or the privileges his daughter had agreed to allow him.)

It should be noticed that *be-*, the old English prefix, renders intransitive verbs transitive. Compare *bewecp* (Sc. 4, 293), *be-speak*, *be-think*, *be-queath*. It also intensifies verbs, as *be-daub*, *be-smear*, *be-spittle*. The syllable *en-* in *en-guard* (317) seems to have the same sense as it has in *en-close*. But Shakspere uses it also to give the force of an active verb to an adjective or noun, as in *em-battle*, *em-free*, *enpoison*. From line 298, it would seem as though a woman's nails had always been deemed her weapons. After *I cannot be so partial, Goneril*, &c. (303, 4), some words must be supplied: *e.g.*, as not to perceive (or admit) that you are acting harshly. Need we allude to *fox* being feminine (309). Students of Latin will recollect the strange rule of the Latin grammar, according to which every fox is a 'she' and every sparrow a 'he' unless recourse be had to the expressions *vulpes mas* ('a male vixen?') and *passer fœmina* ('a female cock-sparrow?') Even Latin grammar, it seems, has its comical side!

In *the harms I fear* (322) the word *harms* is evidently put for 'causes of harm,' and affords an apparent exception to the rule that abstract nouns cannot be put in the plural. Here, of course, it is concrete.

Going back once more to lines 293, 4 of the Fourth Scene we find both *ye* and *you* are employed in the objective case, viz., in 'I'll pluck *ye* out and cast *you*,' &c. This gives us occasion to remind the student that originally *ye* was nominative, and *you* objective (naturally enough, considering that the A.S. original of *ye* was *ge*, and of *you*, *eow*), but the two got mixed up, probably, about the time of the Elizabethan authors. In one or two passages Shakspere actually inverts them, as in the line,—

'I do beseech *ye* if *you* bear me hard.'—*Julius Cæsar.*

The student will easily be able to point out the instances in Sc. 4 in which *sure* and *full* are written for *surely* and *fully*. The exclamation '*I did her wrong*,' Sc. 5, line 23, of course refers to the exiled Cordelia.

Monster ingratitude (37) is perhaps in meaning much the same as '*monstrous* ingratitude,' but it seems as though *monster* were rather a noun in apposition than an adjective. A parallel expression in Latin is the well-known *bellator equus*, the warrior steed, in which the noun *bellator* has the same force as the adjective *bellicus*, warlike.

Thus closes the First Act. Lear's last words are powerfully pathetic. Only those who have watched and listened to a really great actor can imagine what an effect can be produced by the proper delivery of

'O let me not be mad, not mad, sweet heaven,
Keep me in temper; I would not be mad.'

Act Second.

In Act II. there are four Scenes. In Scene 1 we have the meeting of Edmund and his brother Edgar. The crafty Edmund causes Edgar to fly by representing that he is in danger if he stays behind; but no sooner is he gone than Edmund brings a terrible accusation against him. Edgar, he says, has attempted to murder him for the sole reason that he has refused to join him in killing his father. The indignant father believes the story and treats Edgar as an escaped felon.

In Scene 2, occurs a lively encounter between Kent and Oswald, at the end of which Kent is put in the stocks, an ignominy which, since he is Lear's messenger, is tantamount to an insult to the old king. In Scene 3 we encounter Edgar on the heath. He tells us of his flight and how he has disguised himself as a wandering lunatic. In Scene 4 Lear discovers his messenger in the stocks, and is as indignant as could be wished or expected. He insists upon seeing his daughter Regan, and after a time both daughters make their appearance. The old king complains bitterly of the insult offered to Kent, and also of Goneril's proposal to reduce his hundred knights to fifty. Before the quarrel is over, however, he learns that neither daughter will receive him unless he consents to give up his retinue altogether. Lear curses them both, and rushes off, no one knows whither. The friendly Gloster follows his master.

Act II., Sc. 1.

The Duke of Cornwall and Regan his duchess (3). Is any one curious to know the date at which our 'dukes' were instituted? The title was introduced into England by Edward III., who created his son, the Black Prince, Duke of Cornwall, in 1337. The word comes, of course, from the Latin *dux*, which was used as a title of honour by the Roman Governors of provinces under the later Emperors. Our readers will hardly be led astray by the occurrence of the word *duke* in Gen. xxxvi., 15—43. By *ear-kissing arguments*, is meant 'secret subjects of conversation,' or 'closely guarded topics,' in relating which the speaker puts his lips close to the ear of the listener. For *arguments* compare I., 1, 208. *Wars toward* (adv.) are 'wars near at hand.' *Of a queasy question*, means 'which it is a delicate matter to argue upon.' *Briefness and fortune work*. The speaker expresses his intention to 'act quickly and trust to fortune.' *Question* means here not 'interrogation,' but 'investigation,' or 'looking into.' What shall we say about '*good advantage*' (22)?

Upon his party (26) means 'on his side.' Notice the construction *mumbling of wicked charms* (39). Wherefore this *of*? The expression is a shortened form of 'a mumbling of wicked charms,' in which 'a mumbling' is equivalent to 'in the mumbling,' for, of course, *mumbling* is a verbal noun. It is not often that we find *his* contracted into '*s*, as we do here before *auspicious mistress*.

In *my best alarum'd spirits* (53) we are inclined to take *best* as an adverb, and the whole expression seems equivalent to 'my courage, now thoroughly awakened.' Students who meet with *gasted* (55) in the sense of 'frightened' will find it difficult to forget the slang word 'flabbergasted.' They must remember, here, that the original form of the word is not *gasted* but *gastered*, and try to recollect the expression 'god-gastring giants' (god-frightening), which Mr. Wright quotes from an old writer. Notice the old participle *pight* from *pitch*, with the meaning of 'fixed' or 'firmly resolved.' A student need hardly be reminded that *character* means handwriting, being a Greek word put into Roman letters. Notice, too, that curious position of the negative in *not thought* (75) for 'thought not,' which may be compared with 'Tempest' V., 1, 38, '*Whereof the ewe not bites*' (bites not). By *pregnant and potential spurs* is meant

'ready and powerful inducements.' Capable means 'capable of inheriting.' *He did bewray his practice* = 'he betrayed his design.' *Make your own purpose* = 'carry out your own intentions,' *how in my strength you please* = 'just as you please with my strength to assist you.'

Scene 2.

The chief difficulty in this Scene is to find out the meaning of a string of opprobrious expressions used by Kent to Oswald. No doubt each of these was thought witty at the time when the play was introduced. They must, therefore, have been all intelligible, though many of them are scarcely so now.

A three-suited knave can hardly have meant a man with three suits of clothes. To have three suits of clothes at the same time, all of them in good condition, is not at all a ridiculously small wardrobe. Perhaps Shakspere wrote *third-suited*, and meant a man who wore his clothes at third hand. *Lily-livered* is, of course, cowardly, for the old anatomists regarded the liver as the seat of courage, and by mistaken analogy thought that a coward's liver must be light-coloured. *Action-taking* means cowardly also, and denotes a man who, when insulted, brings an action against his adversary instead of fighting him. This behaviour, in rough times, would be thought cowardly. *Superserviceable* and *finical* can only mean 'officious and fanciful.' The student may occupy himself, if he likes, by searching this scene for an anachronism with regard to the naming of children.

'The *composition* of a knave, beggar, coward,' &c., is equivalent to a knave, beggar, coward, &c., '*put together*,' and *addition* means 'the sum of thy titles.' What a *barber-monger* means it is difficult to say. It cannot of course denote a man who sells barbers. Most likely it means a foppish fellow, who goes often to the barber's shop to improve his appearance. *Neat slave* can only mean a trim, spruce rogue.

Among the other epithets we may notice *unbolted* (61), *intrinse* (71), *epileptic* (77), *ducking* (99), *coniunct* (114). *Unbolted* means 'unsifted,' and therefore 'coarse;' *intrinse* is 'tightly drawn,' *epileptic* = 'idiotic,' like the face of a man in a fit; *ducking*, means 'bowing' or 'obsequious,' *conjunct* means here 'in league with the king.'

The omission of a preposition is not infrequent in Shakspere: for instance, *Smile you my speeches?* where 'at' must be understood after *smile*. Among the more difficult passages are *I'll make a sop o' the moonshine of you* (30). Some interpreters say that this refers to a dish called eggs-in-moonshine. If Kent had run him through the body, the bowels would have gushed forth in a manner that would perhaps have been suggestive of broken eggs. According to others the moon's beams were supposed to be moist and cold, and by running him through, Kent would have given his adversary's body a chance to absorb the moonbeams, for which reason he uses the term *a sop*—in either case the threat is the same.

Constrains the garb quite from his nature (93) means 'forces himself to assume a look that is totally at variance with his natural disposition;' *stretch their duties nicely* (100) = 'magnify their duty by their extreme punctiliousness.' He is speaking of courtiers who were so fond of bowing and scraping that they actually gave their masters more of this sort of thing than was expected of them.

'*Under the allowance of your great aspect*' (102), is rather difficult, as Kent has left his rambling speech unfinished. We will suggest that he meant 'If you, O great potentate, will permit me to say so; you whose influence,' &c.; Kent substitutes 'your great aspect' for some such expression as 'your highness,' and *aspect* is explained as being an astrological term, like *influence*. '*Though I should win your displeasure to entreat me to it*' (108), is explained by Dr. Johnson as meaning 'though I should win you over, displeased as you are now, to like me so well as to entreat me to be a knave.' If this be correct, *your displeasure* is equivalent to 'you who are angry,' and adds another to the long list of passages in which the abstract noun is put for the concrete.

Ajax is their fool (121) means, probably, 'Ajax is a fool to them.' The last few lines of this Scene are a perfect quagmire of difficulties, but we must approach them with a resolute determination to leave no difficulty unsifted. Candidates for Examinations had better look out here! The Examiner perhaps has already pencilled some of these passages with a view to putting them in the paper. It is just in such corners as these that he has a chance of picking out something that the student has overlooked or passed over with an impression that it 'could never be set.' They must regard him as the skilled batsman regards a bowler who 'puts on a twist.' Well, first of all, there are those words (157, 8):—

> 'Thou out of heaven's benediction comest
> To the warm sun.'

Does this refer to the expression in James ii., 16? Perhaps it does, but what is the drift of the whole passage? Is this 'a common saw?' Why must the king 'approve' it? and what is meant by 'approve?' A student may be pardoned if, after having read the excellent notes in the Clarendon Press Edition, he still feels in difficulty. Perhaps the meaning is that the king now knows by experience (he does not approve of it, one may be sure) the too common method of relieving beggars, which is, by giving them pity without relief, in the formula quoted from St. James. This, at all events, is one of the explanations given of this very obscure passage. But a comparison of the passages given in the Clarendon Press edition, seems to show that the proverb (saw) 'to go out of God's blessing into the warm sun' means to go from good to worse, and it has possibly been suggested by the circumstance of a man's being discharged from a hospital or charitable retreat ('God's blessing') into the open air. The lines therefore mean, poor king, that hast often been addressed in the words of the old proverb 'you are going from good to bad.'

In the fourth line of his speech, Kent turns away from the king and addresses the sun, which, as it is still dark with the speaker, he addresses as—

> 'Thou beacon to this under globe.'

'*Approach*,' he says to the sun, '*that by thy comfortable* (he means *comforting*) *beams I may peruse this letter*,' and he draws forth a letter from Cordelia. By the words '*Nothing almost sees miracles but misery*,' we presume he means that scarcely any condition of mind is so credulous, so ready to believe in miraculous interposition, as misery is. Kent is right here, and history shows it.

'Cordelia,' soliloquises the speaker, 'has been informed of my obscured course,' that is, of my change of fortune, 'and she will *find time* (*i.e.*, find *a* time, or an opportunity by *seeking* (for it), even out of the present monstrous condition of affairs, to provide remedies for losses.' I find the suggestion given in a little edition of this play which has the merit at all events of seeing where the difficulty of a passage lies, and of trying to clear it up, that *seeking* describes the noun *time*, and that the proper paraphrase is 'shall find time seeking to give losses their remedies,' which assumes of course that Shakspere intended in this passage a personification of time.

The student may, if he likes, commit both explanations to memory, and any other besides, if he can meet with it. But most likely the text is defective. One critic, at least, is of opinion that two half-lines have fallen out of the text between the words *state* and *seeking*.

Lastly, poor Kent addresses his own '*heavy eyes*,' and bids them take advantage of the power to shut out from view ('*take advantage not to behold*') his present ignominious surroundings. We hear him muttering '*Good night, Fortune; smile once more*,' and he falls asleep.

Of verbs we will notice *venege* (74), a very Latin-looking word for 'deny,' *likes me not* (86), for 'pleases me not,' *worthied him* (117), for 'caused him to be thought a worthy man,' stocking (128), for 'placing in the stocks,' and '*sleep out*' (152), for get rid of 'being asleep.'

The words *will not be rubbed* (checked or impeded) in line 150, contain a metaphor from the game of bowls. A *rub* in a bowling alley is an obstacle that may check the ball or turn it aside from its course.

Rather curious is the allusion to the king-fisher ('*halcyon*' 74). The smiling rogues of courtiers will, says Kent,

> '*Turn their halcyon beaks*
> '*With every gale and vary of their masters.*'

Here it is stated, under a similitude, that certain men will use their tongues in defence of their master's policy, no matter how variable and inconsistent it may be. It is assumed in this passage that the body of a dead king-fisher, if hung up in the air, will always point to the direction from which the wind is blowing. (If it merely *followed* the direction of the wind, there would be nothing remarkable.)

Man's science took a long time to develope, and the number of extraordinary things that were at one time believed to be true, but which a very little experimentalising would have shown to be false, is really very remarkable. The reader will call to mind probably a few such beliefs as that life in animals and men only departed when the tide was falling, or the celebrated jewel in the toad's head. But people did not, as it seems, until quite lately, base their beliefs upon experiment and observation. The misery that has been caused in the world by scientific error can only be realised by tracing the actions to which that ignorance gave birth. Not many generations have passed away, for instance, since cruel whipping and confinement in a dark room were honestly believed to be a cure for insanity, and since the medical profession attributed curative properties to the tongue of a fox, which was to be eaten after it had been torn from the living animal! God be thanked, we have learned a little since then!

Scene 3.

The language of Sc. 3 throws a rather unexpected light upon the condition of England in the 'spacious times of great Elizabeth.' As we read these few lines England seems almost as full of beggars as Naples. From various causes the period from the Reformation to the breaking out of the civil wars, was marked by widespread mendicity, a fact which points to the existence of much distress and destitution. The 'Bedlam beggars' were poor, distracted creatures, that, after a certain amount of confinement in a madhouse, had regained, to a limited extent, the use of their faculties, and though still unable to earn a subsistence, were turned loose upon the country to beg, being provided with a license, which was necessary in order to exempt them from the statutory penalties to which beggars were then subjected. These discharged lunatics, thrown upon the world without a friend, wandered about the country, chanting wild ditties, and wearing a fantastical dress to attract the notice and the alms of the charitable. But, in addition to the true 'Tom,' there was a counterfeit, who assumed the grotesque rags, the staff, and the knotted hair of the real one, to excite pity and alarm, and perhaps, in some cases, undeserved charity. We naturally enquire what was the cause of this widespread idleness and destitution? The principal reason, most likely, was that large tracts of arable land had been turned into pasture, in consequence of which vast numbers of agricultural labourers had been thrown out of employment. Then again, the monasteries, whatever their faults, did a vast amount of what is commonly designated as 'charity,' that is to say, they were liberal in the matter of alms-giving. The deserving and the undeserving alike found that they had harder hearts to deal with when the vast estates of the abbeys and monasteries passed from the possession of the Church to that of the rapacious courtiers who seized upon the church lands without any thought of the obligations which their possession entailed. Of all the great changes recorded in history this transfer of the Church property to the king's dependants is one of the most remarkable, and, as we think, unjustifiable, for what the people had contributed they might well have resumed. We have alluded to the severity of the criminal law towards unauthorised beggars. The statutes of Henry VIII.'s reign are simply inhuman. This was the plan adopted for 'stamping out' vagrancy.

The punishment on an offender's being convicted of the offence of 'being a vagabond' was that he should be whipped and burned through the ear with a hot iron an inch in thickness. This is worse than we give nowadays to the vilest malefactor. But if a man whose ear bore the tell-tale brand were again found guilty of the same offence he was punished with death as a felon. Such was the mercy of these 'good old times.'

The details and phraseology of the Fourth Scene we must leave for a subsequent paper.

(To be continued.)

Notes of a Lesson on the Eclipses of the Moon.

BY JOS. H. COWHAM, F.G.S.,

Lecturer on School Method: Westminster Training College.

INFORMATION ARRANGED UNDER HEADINGS.

A. Shadows. (Simple experiments.)

1. The shadow of a sphere is circular in shape. If the light comes from a point the circumference of the shadow is larger than the circumference of the ball.

   N. B.—The screen receiving the shadow must be held perpendicularly to the direction of the shadow in all these experiments.

2. If the ball is smaller than the luminous object (as for instance in the case of the lamp and ball in Fig. 2), the circumference of the shadow is smaller than the circumference of the ball. The further the screen is removed the smaller the shadow becomes.

3. A second shadow, less dark than the first, may frequently be detected surrounding the dark inner shadow.

   The dark inner shadow is termed the **Umbra**, the surrounding and lighter shade is termed the **Penumbra.**

B. Application of the above truths in explanation of the phenomena of Lunar Eclipses.

1. When the earth and moon are in a direct line with the sun, and the moon is on the side of the earth opposite the sun **the moon enters the shadow of the earth and becomes eclipsed.**

2. The Moon can only be in the position described in paragraph 1 when it is **Full Moon** or when it is in **Opposition.**

   Refer to the Lesson on the Phases of the Moon in last month's *Practical Teacher.*

ILLUSTRATIONS, TEACHING HINTS, &c.

Fig. 1.—Showing S, a circular shadow, received on a screen, AB.

The luminous point is at L. P.

Sp. is the position of the ball or sphere whose shadow falls on AB.

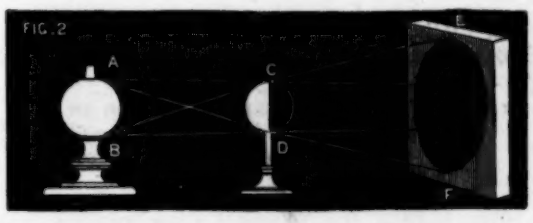


Fig. 2.—The Umbra is represented by the dark circular shade marked U.

Show this experiment, and mark the limits of the Umbra on the screen. Then, by diagram, illustrate its formation by drawing AC and BD continued to the screen EF.

Change the position of the screen EF, the Umbra will be larger or smaller as the screen is moved towards or away from the sphere CD.

Explain by similar methods the position and size of the Penumbra.

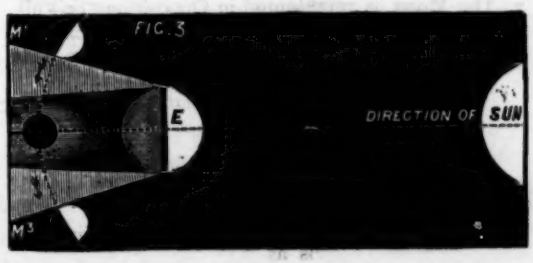


Fig. 3 (*a*).—E represents the Earth with Umbra and Penumbra M1 represents the Moon approaching the Earth's shadow. M2 represents the Moon Eclipsed.

A model constructed in the following way will be very helpful at this stage:—

Take a ball to represent the earth. A cone of black paper may be fitted on to the ball so as to cover the dark half. Let this cone extend some distance in the direction of M2, so as to represent the 'Cone of Shade.' A small ball should be slowly moved across the end of the paper cone, it will illustrate at different points of this movement both **partial** and **total** eclipse of the Moon.

3. Hence an eclipse of the Moon can only occur when the Moon is at, or near **Full Moon.**

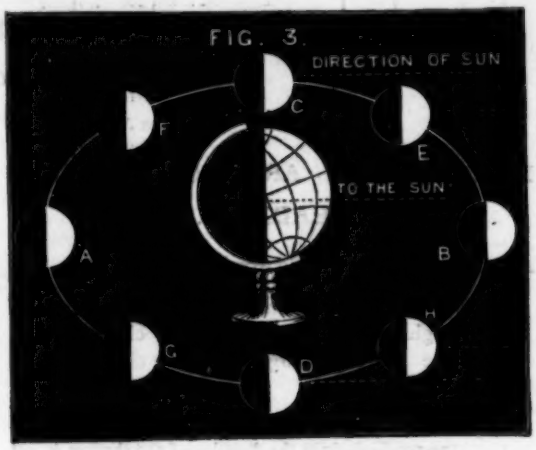


Fig. 3 (*b*).—Compare the Moon's position relative to that of the earth and that of the sun when the Moon is full (A Fig. 3 (*b*)), with the position of the Moon undergoing eclipse in Fig. 3 (*a*). The conditions will be recognised as the same, and account for the eclipse occurring at Full Moon.

Whilst this is true and not difficult to understand, we know from frequent observation that the Moon is not always eclipsed when full. The reason of this is difficult to state and can only be understood by the aid of diagrams and models.

NOTE.—The following paragraphs present an explanation by means of statement and diagrammatic illustration.

C. Why is there not an Eclipse of the Moon every month, viz., at every Full Moon.

1. The Moon moves round the earth in an orbit whose plane is inclined about 5° to the plane of the earth's orbital movement round the sun.

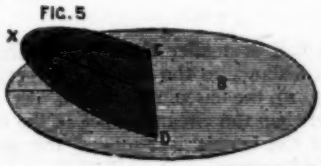


Fig. 5.—Diagram showing A, the upper half of one plane, cutting a second plane B along the line CD.

If the upper plane represent the plane of the Moon's orbit, then when the Moon is at C and D it is in both planes. When the Moon is at the part of its orbit marked X it is furthest away from the second plane.

2. The Moon is represented in Opposition, or Full, in Fig. A, Diagram 6, but is not eclipsed because the Moon is a considerable distance above the earth's shadow.

3. The Moon is represented in Opposition, or Full, again in Fig. B, but in this case it is eclipsed. Why? Because it is not only Full Moon, it is at the same time at, or near, the point where the Moon's orbit crosses the plane of the earth's orbit.

The earth's shadow always stretches away from the sphere with its axis in the plane of the earth's orbit. Hence, when the Moon at Full happens to be near the earth's orbital plane it is eclipsed.

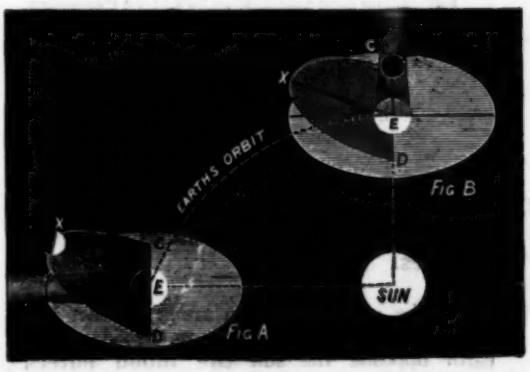


Fig. A.—Shows the conditions in which the moon, though *Full*, is not brought into contact with the earth's cone of shade.

Fig. B.—Exhibits the Moon at Full, at that part of its orbit most favourable for an eclipse.

4. These crossing points, which the Moon must pass every month, are termed **Nodes.** When, therefore, **the Moon is Full and at or near its Nodes it will be eclipsed.**

A model of a very simple kind is very helpful at this stage.

Take a sheet of card-board to represent the earth's orbital plane, mark on it the position of the earth's orbit. Then at the positions occupied by Figures A and B insert differently coloured card-board planes to represent the Moon's orbit. With balls, to represent the position of the sun and that of the earth, and a movable ball to represent the Moon firstly as in Fig. B and secondly as in Fig. A there will be very little difficulty in realizing the conditions favourable for a Lunar Eclipse.

Recent Inspection Questions.

Arithmetic.

INFANTS (BELOW STANDARD I.)

(Dictated).

Add 45, 21, 36, 19. 121. Ans.

STANDARD I.

(*Sums dictated.*)

A.

1.		2.	
	714		804
	66		750
	900		54
	89	3.	120
	7		66
	1,776		54

B.

1.		2.	
	579		806
	99		730
	800		76
	66	3.	413
	7		337
	1,551		76

STANDARD II.

(Sums dictated.)

A. 1. 71,190 ÷ 9. 7,910. Ans.

2. 16,070 − 9,099. 6,971. Ans.

3. 8,769 × 89. 780,441. Ans.

B. 1. 53,824 ÷ 8. 6,728. Ans.

2. 53,075 − 49,069. 4,006. Ans.

3. 86970 × 705. 61,313,850. Ans.

MENTAL ARITHMETIC.

How much left after taking 1s. 6d. from 3s.? How many pence in a florin? How much greater is a half-crown than a florin? How many pence in half-a-crown? How many halfpence? How many farthings? How much left, after taking eighteenpence twice from 17s. 6d.? How many pence in three half-crowns? How many halfpence? How many boys could each get a halfpenny out of half-a-crown? If I gave eightpence each to six boys, how much money would be left out of five shillings?

STANDARD III.

(A Card.)

1. Nine hundred and thirty five thousand and forty, divide by one hundred and twenty eight. 7305. Ans.

2. £6 18s. 4½d. + £70,608 13s. 6½d. + 11s. 9½d. + £807 8s. 7¾d. + £17 17s. 10¼d. + £878.

£72,319 10s. 2½d. Ans.

3. From seventy thousand eight hundred pounds fourteen shillings and eight pence farthing, take seven thousand nine hundred and ninety nine pounds sixteen shillings and two-pence halfpenny.

£62,800 18s. 5¾d. Ans.

4. A boy has a florin, 2 half-crowns, 5 sixpences, 4 pennies, and 2 half pennies; how much does he require to make half a sovereign?

One penny. Ans.

STANDARD IV.

1. Divide two thousand nine hundred and ninety one pounds six shillings and twopence farthing by one hundred and fifty three.

£19 11s. 0½d. Ans.

2. Multiply £3 17s. 10½d. by 94.

£366 0s. 3d. Ans.

3. How many cubic inches are there in 10 cubic yards 144 cubic inches?

466,704 cubic inches. Ans.

4. If a man's step is 2 ft. 4 ins. and a boy's step is 2 feet, how many steps does the boy take more than the man in going a distance of 3½ miles?

Boy's steps 9,240
Man's steps 7,920

Diff. 1,320 Ans.

STANDARD V.

1. Find the value of 218 tons of coal at 18s. 10d. per ton?

£205 5s. 8d. Ans.

2. Make out the following bill:—12 yards of calico at 3¾d. per yd., 9½ yds. of linen at 11d. per yd., 7 yds. of alpaca at 1s. 10½d. per yd., 5 pairs of gloves at 2s. 8d. a pair.

(3s. 9d. + 8s. 8½d. + 13s. 1½d. + 13s. 4d.)

£1 18s. 11d. Ans.

3. If 24 men reap a field in 5 hours, in what time could 80 men reap it?

men men hrs. hrs.
80 : 24 :: 5 : 1½. Ans.

4. What must I add to $\frac{3}{8}$ to make it equal to $\frac{4}{5} + \frac{1}{10} - \frac{1}{2}$.

$$(\tfrac{4}{5} + \tfrac{1}{10} - \tfrac{1}{2}) - \tfrac{3}{8}$$
$$= (\tfrac{8}{10} + \tfrac{1}{10} - \tfrac{5}{10}) - \tfrac{6}{10}$$
$$= \tfrac{1}{10}. \text{ Ans.}$$

STANDARD VI.

1. Divide 1·17 by 468 and multiply the quotient by ·18.

(1·17 ÷ 468) × ·18

= ·00045. Ans.

2. Reduce $\frac{3}{16}$ £ to the fraction of £1 10s. 6d.

$$\frac{\frac{3}{16}\text{£}}{\text{£1 10s. 6d.}} = \frac{3\text{s. 9d.}}{30\text{s. 6d.}} = \frac{15}{253}. \text{ Ans.}$$

3. Find the simple interest on £575 for 300 days at 3⅓ per cent. per annum.

£100 : 575 :: £3⅓ : £15 15s. $0\frac{60}{253}$d. Ans.
days 365 : 300

4. If 5 boys earn £14 10s. in 29 days in what time will 15 boys earn £30?

boys 15 : 5 :: 29 days : 20 days. Ans.
£14½ : 30

STANDARD VII.

1. What per centage of coffee and chicory is there in a bag containing 3 cwt. 3 qrs., of which 1 qr. 14lbs. is coffee?

3 cwt. 3 qrs. − 1 qr. 14 lbs. = 3 cwt. 1 qr. 14 lbs.

cwt.	qr.		cwt.	qr.	
3	3	: 100 ::	3	1½	: 90 chicory
3	3	: 100 ::		1½	: 10 coffee

2. What is the interest on £216 13s. 4d. for 3 yrs. 219 days at 5 per cent?

219 days = $\frac{219}{365}$ = $\frac{3}{5}$ yr.

£100 : £216 13s. 4d. :: £5 : £39. Ans.

yrs. 1 : $3\frac{3}{5}$

3. A man gains $12\frac{1}{2}$ per cent. by selling a horse for £54, what will he gain per cent. by selling it for £56?

£54 : £56 :: $112\frac{1}{2}$: $116\frac{2}{3}$

Gain per cent. = $116\frac{2}{3}$ − 100 = $16\frac{2}{3}$. Ans.

4. A train travels at the rate of 36 miles per hour for 15 minutes, then at 40 miles per hour for the next 15 mins., and then at 45 miles per hour for next 30 mins. Find the average rate per hour.

		miles	miles
In 1st quarter it will travel	$\frac{1}{4}$ of 36	=	9
In 2nd "	" $\frac{1}{4}$ of 40	=	10
In last half	" $\frac{1}{2}$ of 45	=	$22\frac{1}{2}$
Av. number of miles per hour		=	$41\frac{1}{2}$

Dictation.

INFANTS (BELOW STANDARD I.)

Write in large hand from dictation the following words: Bring, face, grand, Jack, mother, school.

STANDARD I.

A.

Ground, Winter, Garden, Leaf, Water, Crumbs.

B.

Garden, Flowers, Winter, Frost, Girls, Cheeks.

STANDARD II.

In some parts of the world, as in Arabia and Persia, he lives wild among the mountains. In his wild state he runs very swiftly; his skin is smooth and his legs very slender. In these lands he is considered the most handsome of all animals. The Arabs bestow very great care upon him.

STANDARD III.

More than three hundred years ago there stood near a small town on the coast of Spain an ancient convent. It still stands there, on a height above the sea, surrounded by a forest of pine trees.

A stranger, travelling on foot; with a little boy, one day stopped at the gate of the convent and asked the porter to give him a little bread and water for his child.

STANDARD IV.

The youth was summoned and informed that his plans had been accepted, and that the prize was his. The gentleman then said that he must put up the building; and his employer was so pleased with his success that he willingly gave him permission to go. The studious, painstaking carpenter became a great architect. He made a fortune, and rose high in public estimation, while his fellow apprentice continued to be an inferior workman.

STANDARD V.

A.

A short story was read.

B.

Happily their rugged snow-capped mountains forbid the tillers and other dwellers to live in idleness. The very unevenness of the ground, bringing every muscle into play, maintains the bodily health of those who have to go up and down on their business.

The soil, climate, and minerals of Europe, however, though they discourage sloth, are such as well repay toil. Hence, many of its inhabitants have leisure to follow the arts, to study sciences, and to think high thoughts for the behoof of the masses.

STANDARD VI.

Write a composition on 'Julius Cæsar' or 'The Locomotive.'

Grammar.

STANDARD II.

Pick out nouns and verbs from the following:—

A.

A fox was one day taking a walk in the country. It was a hot summer day; and the heat soon made him feel very thirsty. No spring of clear fresh water was near.

B.

'Keep still, my boys!' said the boatman. They sat down and kept very quiet. But it was for a short time only. Tom wanted to have a stick that Ned was holding in his hand.

STANDARD III.

A.

Pick out pronouns, adjectives and verbs from the first verse of 'The Better Land.'

B.

Pronouns, adjectives and adverbs from the following:—As a dog was crossing a brook with a bone in his mouth, he saw his own image in the clear water, and mistook it for another dog carrying another bone. Not content with what he himself possessed, the greedy creature snatched at the prize which he saw below.

STANDARD IV.

A.

Parse:—

Music is a very pleasant study.

B.

'Beside the ungathered rice he lay.'

STANDARD V.

A.

Analyse and parse:—

'But why do I talk of death.'

B.

'A woman sat in unwomanly rags plying her needle and thread.'

STANDARD VI.

A.

Analyse and parse:—

'I speak not to disprove what Brutus spoke.'

B.

'It is not linen you are wearing out.'

Geography.

STANDARD II.

What is a river? Name one? Another? What do rivers do? What is that river called which joins another? Name a tributary to any river? Name the oceans? What is an ocean? Is there any ocean near England? What is its name? What is the water called to the east of England? What is an isthmus? Name one? A peninsula? Tell me the name of one? What is the water called which fills up any hollow in the land? What is the land called when it stretches into the water?

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—*'The Query Editor,' The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

General.

1. PET BEN.—Your solution is quite correct. The answer in the book is wrong.

2. T. JONES.—You do not say so, but we presume you are an acting teacher. You will find the instructions quite explicit. If you have not passed in the compulsory subjects of the first year you cannot take the language paper, and it is only as a substitute for a part of that that the Political Economy counts. You will get credit for the science certificates which you possess. Acting teachers who have not been examined in the preceding year, or, having been examined, have failed to obtain a certificate, must take up both groups (c) and (d), and as (a) and (b) are compulsory, and as only four groups can be taken in all, you see that the question of languages and economy are out of question.

3. TONE.—The writing is very bad at present; you do not state your age; you may be only a candidate. Try to improve, and then we will estimate your writing again. Large 30; small 40.

4. LUCY.—We advise (A). (A) would get 70 and (B) 60.

5. DAVID WILLIAMS.—Large hand 60; small hand 65. There seems to be no attempt at forming the letters according to recognized types. You are not at liberty to make the letters change shapes with the fashions.

6. HORACE.—Yes, we think so. Meantime as a preparation you could be reading an easy book, or selections from authors. Latin Principia, Pt. II., would suit you very well. Use the old style of pronunciation at present; there is less uniformity about the new; nor is it firmly established yet. Writing very fair. 75.

7. EURIPIDES.—Large hand 50; small hand 70. You will see that the large hand needs much improvement; a few of the letters are well formed, one S is, but the W and N are by no means so perfect. The number of marks given is not published; you cannot find out, nor could you draw any useful conclusion if you knew. The class you finally get may not depend upon the absolute number of marks you obtain.

8. S.C.—Large hand, not one letter of the correct shape. You must recognize that there are acknowledged shapes for the letters and you must imitate them. You seem to prefer variety to uniformity; you don't write the same letter in the same way twice over. The small hand is better and is decidedly legible. The letters are ill shaped and inelegant. Detailed criticism is needless till you have learned to imitate good copies. Large 30, small 45.

9. ECRICK.—We have not seen the book you name.

10. FAITH.—Chiefly want of ease and elegance and style. It is worth about 50.

11. ———— Hybrid words are those in which one part is derived from one language, and the other part from another, as un-grateful, para-sol, un-sympathetic. You will find plenty of examples in English, where the root is from one language, and the prefix or affix is from another.

12. FERRAMIS.—
Deor is deer, Gwent a plain,
Derby is from Deor, deer and by a town.

13. H. H. M.—One who has matriculated but not yet obtained a degree is an undergraduate. Try Zootomy, by T. J. Parker (Macmillan).

14. EMERSON.—We cannot undertake to assess the comparative value in percentages of separate answers of competitors in the Pupil Teacher Competition. We may point out however that your proof of the identity in Question 2 of the Algebra paper is not a direct one, and a higher value always attaches to answers in which the identity is deduced by direct steps from the data. Then, though your solution to the last equation in Question 3 brings out a correct result, it is needlessly complicated by being brought into the form of a cubic equation; the obvious clue to a neat solution is in resolving the fraction $\frac{x-1}{\sqrt{x}-1}$ into its equivalent, $\sqrt{x}+1$. Your paraphrase is fairly good, and your answer to the first part of Question 4 in History is good, and would obtain nearly full marks.

15. LINCOLN.—Reading is not now a part of the Scholarship Examination. It used to be. The writing you have sent would bring about 75 per cent. of the marks. It is very legible though few of the letters will bear examination. The large hand is no better in this respect. 70.

16. NOM-DE-PLUME.—For School management use *Gladman's* (Collins) Notes or *Langton's* (Kegan Paul). You do not give particulars. Perhaps you have not seen *Professor Sully's* (Longman) smaller work on Psychology as applied to education. *Corfield's* (Longman) 'Laws of Health' will suit you very well. There is as yet no suitable book on the other subject.

17. A STRIVING STUDENT.—You say your memory is bad and you want to improve it; a very worthy object. You will succeed if you try and persevere. Most likely, however, you want what you call a good memory at once. You would like to be able to read a page and then easily reproduce it in substance and perhaps in form. Don't believe anybody who promises you that power. It will come slowly if at all. But you can certainly improve your memory and make it good enough for all practical purposes. The main points to be observed are these: Work when your brain is fresh, not when it is exhausted; take great interest in your work; pay attention to it; arrange it in an orderly and logical manner, and then go over once or twice in the day what you learned in the morning. You will soon find that you can trust your memory. You were taken in, in regard to the book you name. People who want easy royal roads to learning are always taken in and deserve to be so.

18. FOGGY.—(A) Letters imperfectly formed, curves irregular and uneven, too upright, 60. (B) The capital letter good, the rest have the faults of (A), 65. (C) Neat, legible and promising. You seem to have learned to write from bad and wrongly formed copies. In the word mother, not one of the letters will bear examination. Get some good copies and practise, you will soon write well.

19. XENOPHON.—Much depends upon your opportunities. If you have a good teacher, it does not matter which; if you are relying upon yourself, try the French.

20. J. S. POOL.—Yes, we believe you could get a first class in the way you describe; of course you must do well in them. The writing is pretty good. Large 80; small 85.

21. G. T. J. PARKER.—Macmillan and Co. Any good botany will supply what you want to know of *Pinus* and a Moss. *Thomé's* Botany (Longman & Co.) is a handy manual, but there are several others.

22. MALDWYN.—Obtain a syllabus of the requirements. *Huxley's* 'Physiography' does not cover the course. Add *Findlater's* 'Physiography.' Observe as you go about, and try to study the subject intelligently. You can sit at the nearest centre next May. Write to the Secretary, Science and Art Department, South Kensington, to find out when that is, about next March.

23. YE KINGDOM OF FIFE.—You are quite right. No mention of the person of nouns is made by the authorities you name. They don't think nouns have any person, and therefore say nothing about it. Many recent grammarians lean towards the exclusion of fictions from our text books. Read *Dr. Abbott's* 'How to Parse,' and 'How to tell the Parts of Speech.'

24. C. F. HAYWARD.—Something depends upon the examiners. Read the test questions last set. You are perhaps aware that M. Esclangon has just published some useful books. You will find *Karcher's* 'Poetical Reader' good, and also the Second Part of the 'French Principia.'

25. FABIOLA.—(1) For 3rd stage use *Lock's* 'Trigonometry,' if possible, if not, *Todhunter's*. (2 and 3) Yes; compare the syllabus with the contents, and do the same with *Todhunter's* 'Algebra.' You had better get the questions for the last four years, and see what subjects are most examined upon. In the examiner's opinion they are the most important. The study of geometry is progressing. It would be unwise now to be satisfied with *Todhunter's* 'Euclid.' You will thank us for calling your attention to *Casey's* 'Elements of Euclid,' to *Mackay's* 'Elements of Euclid,' and to Euclid revised by *Nixon*. (4) Possibly for advanced; not more. (5) Yes. (6) Arithmetics 2d. each. For teachers use 'Catch Questions in Arithmetic.'

26. G. A. W. W.—See our issue for June, 1885—General Queries—No. 36.

R and another next month.

Algebra.

1. FOLKESTONIAN.—Find the rate of Interest (Compound) on the following:—

A borrows of B £100, which A is to repay in monthly instalments to be carried over ten years.

1st year	£1	5s.	10d.	monthly;
2nd ,,	£1	5s.	0d.	,,
3rd ,,	£1	4s.	2d.	,,
4th ,,	£1	3s.	4d.	,,
5th ,,	£1	2s.	6d.	,,
6th ,,	£1	1s.	8d.	,,
7th ,,	£1	0s.	10d.	,,
8th ,,	£1	0s.	0d.	,,
9th ,,		19s.	2d.	,,
10th ,,		18s.	4d.	,,

Let P denote the present value in pounds of the payments made in one year, A a monthly payment in pounds, n the number of payments in one year, and R the amount of one pound in one month; then

1st year:— $P = \frac{A}{R-1}\left(1-\frac{1}{R^n}\right) = \frac{\frac{1}{12}}{R-1}\left(1-\frac{1}{R^{12}}\right)$;

2nd ,, $P = \frac{A}{R-1}\left(\frac{1}{R^n}-\frac{1}{R^{n+12}}\right) = \frac{\frac{1}{12}}{R-1}\left(\frac{1}{R^{12}}-\frac{1}{R^{24}}\right)$;

3rd ,, $P = \frac{\frac{1}{12}}{R-1}\left(\frac{1}{R^{24}}-\frac{1}{R^{36}}\right)$;

&c., &c.

$$\therefore 100 = \frac{1}{R-1}\left\{\frac{1}{12}\left(1-\frac{1}{R^{12}}\right)+\frac{1}{12}\left(\frac{1}{R^{12}}-\frac{1}{R^{24}}\right)+\frac{1}{12}\left(\frac{1}{R^{24}}-\frac{1}{R^{36}}\right)+\frac{1}{12}\left(\frac{1}{R^{36}}-\frac{1}{R^{48}}\right)+\frac{1}{12}\left(\frac{1}{R^{48}}-\frac{1}{R^{60}}\right)+\frac{1}{12}\left(\frac{1}{R^{60}}-\frac{1}{R^{72}}\right)+\frac{1}{12}\left(\frac{1}{R^{72}}-\frac{1}{R^{84}}\right)+\left(\frac{1}{R^{84}}-\frac{1}{R^{96}}\right)+\frac{1}{12}\left(\frac{1}{R^{96}}-\frac{1}{R^{108}}\right)+\frac{1}{12}\left(\frac{1}{R^{108}}-\frac{1}{R^{120}}\right)\right\}$$

$$100(R-1) = \frac{1}{12}-\frac{1}{12}\left(\frac{1}{R^{12}}+\frac{1}{R^{24}}+\ldots\ldots+\frac{1}{R^{120}}\right)$$

$$2400(R-1) = 31-\frac{1}{R^{12}}\left(1+\frac{1}{R^{12}}+\ldots\ldots+\frac{1}{R^{108}}\right)$$

$$= 31-\frac{1}{R^{12}}\times\frac{\frac{1}{R^{12}}\times\frac{1}{R^{108}}-1}{\frac{1}{R^{12}}-1}$$

$$= 31-\frac{1}{R^{12}}\times\frac{\frac{1}{R^{120}}-1}{\frac{1}{R^{12}}-1}$$

$$= 31-\frac{R^{120}-1}{R^{120}(R^{12}-1)};$$

The rate of interest will be found *by trial* to be 13 %; thus—

$R = 1 + \frac{1}{12}$ of $\frac{1}{100} = 1\frac{1}{1200} = 1{\cdot}01083$;

log. R = ·0051089,
log. R^{12} = ·061368,
log. R^{120} = ·613068;
$\therefore$ R^{12} = 1·15161,
R^{120} = 4·10268;

$$2400(1\tfrac{1}{1200}-1) = 31-\frac{4{\cdot}10268-1}{4{\cdot}10268(1{\cdot}15161-1)}$$

$$2400\times\tfrac{1}{1200} = 31-\frac{3{\cdot}10268}{4{\cdot}10268\times{\cdot}15161}$$

$$26 = 31-\frac{3{\cdot}10268}{{\cdot}6220073148}$$

$$= 31-5 \text{ (nearly)}$$
$$= 26,$$

$\therefore$ Rate of interest = 13 per cent. Ans.

2. MISTY.—A man lives within reach of three boys' schools and four girls' schools. In how many ways can he send his three sons and two daughters to school? ('Choice and Chance,' by *Whitworth*.)

No. of ways for boys alone = $\lfloor 3 = 6$;
,, ,, girls ,, = $4.3 = 12$;
$\therefore$ Total No. of ways = 6×12
= 72. Ans.

3. DAVID WILLIAMS.—Solve:—

$x+y+z=a+b+c$, $x+a=y+b=z+c$. (*Todhunter.*)

$x+y+z = a+b+c$
$x-y = -a+b$

Adding $2x + z = 2b+c$ (1)

$x+y+z = a+b+c$
$y-z = -b+c$

Subtracting $x+2z = a+2b$ (2)

(1) × 2 $4x+2z = 4b+2c$
(2) $x+2z = a+2b$

Subtracting $3x = -a+2b+2c$
$= 2(a+b+c)-3a$
$\therefore x = \frac{1}{3}(a+b+c)-a$.

$y+b = x+a$
$= \frac{1}{3}(a+b+c)-a+a$
$\therefore y = \frac{1}{3}(a+b+c)-b$.

$z+c = x+a$
$= \frac{1}{3}(a+b+c)-a+a$
$\therefore z = \frac{1}{3}(a+b+c)-c$.

4. HANNIBAL.—Find all the values of x and y that satisfy the equations—

$$\frac{x-y+1}{x+y+2}+\frac{x-y+1}{x+y} = 4;$$

$$9+\frac{16}{x-y+1}+\frac{4}{x+y} = 0.$$

(Mathematics, Stage III., 1883.)

(1) $\frac{x-y+1}{x+y+2}+\frac{x-y+1}{x+y} = 4$
(2) $9+\frac{16}{x-y+1}+\frac{4}{x+y} = 0$

(1) $(x-y+1)(x+y+x+y+2) = 4(x+y)(x+y+2)$
$(x-y+1)(2x+2y+2) = 4(x+y)(x+y+2)$
$(x-y+1)(x+y+1) = 2(x+y)(x+y+2)$
$\therefore x-y+1 = \frac{2(x+y)(x+y+2)}{(x+y)+1}$.

$$(2)\quad \frac{16}{x-y+1} = -9 - \frac{4}{x+y}$$

$$= -\frac{9(x+y)+4}{x+y}$$

$$\frac{x-y+1}{16} = -\frac{x+y}{9(x+y)+4}$$

$$\therefore x-y+1 = -\frac{16(x+y)}{9(x+y)+4}.$$

$$\therefore \frac{2(x+y)(x+y+2)}{(x+y)+1} = -\frac{16(x+y)}{9(x+y)+4}$$

$$\frac{(x+y)+2}{(x+y)+1} = -\frac{8}{9(x+y)+4}$$

$$9(x+y)^2 + 22(x+y) + 8 = -8(x+y) - 8$$

$$9(x+y)^2 + 30(x+y) = -16$$

$$(x+y)^2 + \tfrac{10}{3}(x+y) = -\tfrac{16}{9}$$

$$(x+y)^2 + \tfrac{10}{3}(x+y) + (\tfrac{5}{3})^2 = \tfrac{25}{9} - \tfrac{16}{9}$$

$$= 1$$

$$(x+y) + \tfrac{5}{3} = \pm 1$$

$$\therefore x+y = \pm 1 - \tfrac{5}{3}$$

$$= -\tfrac{2}{3}, \text{ or } -\tfrac{8}{3}.$$

$$x-y+1 = -\frac{16(x+y)}{9(x+y)+4}$$

$$= -\frac{16\times -\frac{2}{3}}{(9\times -\frac{2}{3})+4}, \text{ or } -\frac{16\times -\frac{8}{3}}{(9\times -\frac{8}{3})+4}$$

$$= -\frac{\frac{32}{3}}{6+4}, \text{ or } -\frac{\frac{128}{3}}{24+4}$$

$$= -\tfrac{16}{15}, \text{ or } -\tfrac{32}{21}$$

$$\therefore x-y = -\tfrac{16}{15} - 1, \text{ or } \tfrac{32}{21} - 1$$

$$= -\tfrac{31}{15}, \text{ or } -\tfrac{43}{21}.$$

$$\left.\begin{aligned} x+y &= -\tfrac{2}{3}, \text{ or } -\tfrac{8}{3} \\ x-y &= -\tfrac{31}{15}, \text{ or } -\tfrac{43}{21} \end{aligned}\right\}$$

$$\left.\begin{aligned} \text{Adding } 2x &= -\tfrac{41}{15}, \text{ or } -\tfrac{100}{21} \\ \text{Subtracting } 2y &= \tfrac{27}{15}, \text{ or } -\tfrac{1}{7} \end{aligned}\right.$$

$$\left.\begin{aligned} \therefore x &= -\tfrac{41}{30}, \text{ or } -\tfrac{100}{42} \\ y &= \tfrac{27}{30}, \text{ or } -\tfrac{1}{14} \end{aligned}\right\}$$

5. DHAWALAGIRI.—Find in what scale 16,000 is denoted by 1,003,000. (*Todhunter.*)

Let x denote the radix,

Then, $x^6 + 3x^3 = 16{,}000$

Completing the square $x^6 + 3x^3 + (\frac{3}{2})^2 = 16{,}000 + \frac{9}{4}$

$$= \tfrac{64009}{4}$$

Extracting square root $x^3 + \frac{3}{2} = \pm\frac{253}{2}$

$$x^3 = \pm\tfrac{253}{2} - \tfrac{3}{2}$$

$$= 125, \text{ or } -128$$

$$\therefore x = 5, \text{ or } \sqrt[3]{-128}$$

∴ Radix of scale = 5. Ans.

Note.—A complete sketch of the life and work of Fröbel appeared in vols. 3 and 4 of the 'Practical Teacher.'

6. PUZZLED.—The volume of a frustrum of a cone is 105π cubic feet, the height is $6\frac{2}{3}$ feet, and the diameter of the base is 4 feet more than the top. Find the other dimensions.

If a^2 and b^2 represent the areas of the two ends of the frustrum, and h the height, then

$$\text{Volume} = \frac{h}{3}(a^2 + ab + b^2);$$

$$\therefore 105\pi \text{ cub. ft.} = \frac{6\frac{2}{3}\text{ft.}}{3}(a^2 + ab + b^2);$$

Let x denote the diameter of the top in feet,

$$\therefore 105\pi = 2\tfrac{1}{2}\left[\left\{(x+4)^2 \times \frac{\pi}{4}\right\} + \left\{x(x+4)\times\frac{\pi}{4}\right\} + \left(x^2\times\frac{\pi}{4}\right)\right]$$

$$420 = \tfrac{15}{2}[(x+4)^2 + x(x+4) + x^2]$$

$$420\times\tfrac{2}{15} = x^2 + 8x + 16 + x^2 + 4x + x^2$$

$$196 = 3x^2 + 12x + 16$$

$$3x^2 + 12x = 196 - 16$$

$$= 180$$

$$x^2 + 4x = 60$$

$$x^2 + 4x + (2)^2 = 60 + 4$$

$$= 64$$

$$x + 2 = \pm 8$$

$$x = \pm 8 - 2$$

$$\therefore x = 6, \text{ or } -10.$$

∴ Diameter of top = 6 feet;

Diameter of bottom = (6 + 4) ft. = 10 feet;

$$\text{Slant Height} = \sqrt{(6\tfrac{2}{3})^2 + (2)^2}\text{ ft.}$$

$$= \sqrt{\tfrac{1024}{225} + 4}\text{ ft.}$$

$$= \sqrt{\frac{2025 + 196}{49}}\text{ ft.}$$

$$= \sqrt{\tfrac{2221}{49}}\text{ ft.}$$

$$= \frac{47\text{·}12\ldots}{7}\text{ ft.}$$

$$= 6.73\ldots\text{ ft.}$$

7. A PRACTICAL TEACHER.—Solve:—

$$\left.\begin{aligned} x+y &= a+b \\ \frac{x+a}{b} &= \frac{y+b}{a} \end{aligned}\right\} \text{ (*Certificate*, 1882.)}$$

$$\left.\begin{aligned} (1)\quad x+y &= a+b \\ (2)\quad \frac{x+a}{b} &= \frac{y+b}{a} \end{aligned}\right\}$$

$$(1)\quad y = a+b-x;$$

$$(2)\quad \frac{x+a}{b} = \frac{a+b-x+b}{a}$$

$$= \frac{a+2b-x}{a}$$

$$ax + a^2 = ab + 2b^2 - bx$$

$$(a+b)x = 2b^2 + ab - a^2$$

$$= (b+a)(2b-a)$$

$$\therefore x = 2b - a.$$

$$(1)\quad y = a+b-x$$

$$= a+b-(2b-a)$$

$$= a+b-2b+a$$

$$= 2a - b.$$

8. CLAONA.—Solve:—

$$\left.\begin{aligned} xy &= x+y \\ xz &= 2(x+z) \\ yz &= 3(y+z) \end{aligned}\right\} \text{(*Colenso.*)}$$

$$(1)\quad xy = x+y$$

$$xy - y = x$$

$$(x-1)y = x$$

$$\therefore y = \frac{x}{x-1}.$$

$$(2)\quad xz = 2(x+z)$$

$$xz - 2z = 2x$$

$$(x-2)z = 2x$$

$$\therefore z = \frac{2x}{x-2}.$$

$$(3)\quad yz = 3(y+z)$$

$$\frac{x}{x-1}\times\frac{2x}{x-2} = 3\left(\frac{x}{x-1} + \frac{2x}{x-2}\right)$$

$$\frac{2x^2}{(x-1)(x-2)} = \frac{3(x^2 - 2x + 2x^2 - 2x)}{(x-1)(x-2)}$$

$$2x^2 = 3(3x^2 - 4x)$$

$$= 9x^2 - 12x$$

$$7x^2 = 12x$$

$$7x = 12$$

$$\therefore x = 1\tfrac{5}{7},$$

$$y = \frac{x}{x-1} = \frac{\frac{12}{7}}{\frac{5}{7}} = 2\tfrac{2}{5};$$

$$z = \frac{2x}{x-2} = \frac{\frac{24}{7}}{-\frac{2}{7}} = -12.$$

9. A PRACTICAL TEACHER.—Solve:—

$$\sqrt[4]{\frac{x-a}{x+a}} + \sqrt[4]{\frac{x+a}{x-a}} = \sqrt{5}.$$

(*Certificate*, 1882.)

$$\sqrt[4]{\frac{x-a}{x+a}} + \sqrt[4]{\frac{x+a}{x-a}} = \sqrt{5}.$$

Squaring each side

$$\sqrt{\frac{x-a}{x+a}} + 2\sqrt[4]{\frac{x-a}{x+a}\times\frac{x+a}{x-a}} + \sqrt{\frac{x+a}{x-a}} = 5$$

$$\sqrt{\frac{x-a}{x+a}} + 2 + \sqrt{\frac{x+a}{x-a}} = 5$$

$$\sqrt{\frac{x-a}{x+a}} + \sqrt{\frac{x+a}{x-a}} = 3$$

Squaring each side $\left.\begin{matrix}\\\\\end{matrix}\right\}$ $\frac{x-a}{x+a} + 2\sqrt{\frac{x-a}{x+a}\times\frac{x+a}{x-a}} + \frac{x+a}{x-a} = 9$

$$\frac{x-a}{x+a} + 2 + \frac{x+a}{x-a} = 9$$

$$\frac{x^2-2ax+a^2+x^2+2ax+a^2}{x^2-a^2} = 7$$

$$2x^2+2a^2 = 7x^2-7a^2$$

$$7x^2-2x^2 = 7a^2+2a^2$$

$$5x^2 = 9a^2$$

$$x^2 = \frac{9a^2}{5}$$

$$\therefore x = \pm\frac{3a}{\sqrt{5}}$$

10. ROB ROY.—Find the square root of :—

$$a - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + 3a^{\frac{1}{2}}b^{\frac{1}{2}} - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b.$$

$$a - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + 3a^{\frac{1}{2}}b^{\frac{1}{2}} - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b\,(a^{\frac{1}{2}} - a^{\frac{1}{2}}b^{\frac{1}{2}} + b^{\frac{1}{2}}$$

$$\begin{array}{l|l} a & \\ \hline 2a^{\frac{1}{2}} - a^{\frac{1}{2}}b^{\frac{1}{2}} & -2a^{\frac{1}{2}}b^{\frac{1}{2}} + 3a^{\frac{1}{2}}b^{\frac{1}{2}} \\ & -2a^{\frac{1}{2}}b^{\frac{1}{2}} + a^{\frac{1}{2}}b^{\frac{1}{2}} \\ \hline 2a^{\frac{1}{2}} - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b^{\frac{1}{2}} & 2a^{\frac{1}{2}}b^{\frac{1}{2}} - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b \\ & 2a^{\frac{1}{2}}b^{\frac{1}{2}} - 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b \end{array}$$

$\therefore$ Square root $= a^{\frac{1}{2}} - a^{\frac{1}{2}}b^{\frac{1}{2}} + b^{\frac{1}{2}}$.

11. TEDDINGTON.—Find the number of permutations that can be formed out of the letters in the word Proposition. (*Hamblin Smith.*)

No. of letters = 11 ;

Letter p occurs twice,
" o " three times,
" i " twice ;

$$\therefore \text{No. of permutations} = \frac{\lfloor 11}{\lfloor 2 \,\lfloor 3 \,\lfloor 2}$$

$$= \frac{11.\,10.\,9.\,8.\,7.\,6.\,5.\,4.\,3.\,2.\,1.}{1.\,2.\,1.\,2.\,3.\,1.\,2.}$$

$$= 11.\,10.\,9.\,8.\,7.\,6.\,5.$$

$$= 1{,}663{,}200. \quad \text{Ans.}$$

Arithmetic.

1. FOUR.—On the 1st of January, 1870, a contractor borrows a sum of money at 5 per cent., simple interest. At the end of a year the rate of interest is reduced to $4\frac{1}{2}$ per cent. The total amount of interest up to the end of 1875 is £1,760. What was the sum borrowed?

Interest on £100 for the 6 years $= £5 + (£4\frac{1}{2}\times 5)$
$= £26\frac{1}{2}$;

£	£	£	
$26\frac{1}{2}$	1760	100	: Sum borrowed.
4	4		
105	7040		
21	)140800		
	£6704 15s. $2\frac{8}{21}$d.		Ans.

2. JENNIE.—A dealer buys 80 tons of coals, and after selling them again at 1s. 6d. per sack, finds that he has gained £4. Had he sold them at 1s. 4d. per sack, he would have lost £6. Find the cost price per ton, and the weight of a sack of coals. (*Barnard Smith.*)

Difference of (1s. 6d. — 1s. 4d.) per sack gives a difference of (£4 + £6),

Difference of 2d. per sack gives a difference of £10 ;

$\therefore$ No. of sacks $=$ £10 ÷ 2d.
$= 1{,}200.$

$$\text{Cost price per ton} = \frac{(1\text{s. }6\text{d.}\times 1{,}200) - £4}{80}$$

$$= \frac{£90 - £4}{80}$$

$$= \frac{£86}{80}$$

$$= £1\ 1\text{s. }6\text{d.} \quad \text{Ans.}$$

$$\text{Weight of a sack} = \frac{80 \text{ tons}}{1{,}200}$$

$= \frac{1}{15}$ ton
$= 1\frac{1}{2}$ cwt.
$=$ 1 cwt. 1 qr. $9\frac{1}{7}$ lbs. Ans.

3. ANNIE LINDSAY.—A friend lent me £475 at 4 per cent., and to raise the money he sold out at 3 per cent. consols when they were at $87\frac{3}{8}$, brokerage $\frac{1}{8}$. I kept the money 3 months, and meanwhile the funds rose to $91\frac{1}{8}$. How much have I to pay my friend, to cover the interest and to replace the stock he previously held, brokerage $\frac{1}{8}$?

£$(87\frac{3}{8} - \frac{1}{8})$: £$(91\frac{1}{8} + \frac{1}{8})$ :: £475 : Amount reqd. to re-purchase the stock.

$\therefore$ £$87\frac{1}{4}$: £$91\frac{1}{4}$ :: £475 : Amount.

8	8		19
700	733		
28	19		
28)13927			
£497 7s. $10\frac{1}{2}$d.			

$\therefore$ Amount to be paid $=$ £497 7s. $10\frac{1}{2}$d.
$+ [(4\%$ on £475$) \times \frac{1}{4}]$
$=$ £497 7s. $10\frac{1}{2}$d. $+$ £4 15s.
$=$ £502 2s. $10\frac{1}{2}$d. Ans.

4. PUZZLED.—If money invested in the 3 per cent. consols gives exactly 3 per cent. after paying 5d. in the pound income-tax, what is the price of the consols? (*Capel's* 'Catch Questions.')

$$\text{Percentage with income-tax} = £3\times\frac{£1}{£1 - 5\text{d.}}$$

$= £3\times\frac{240}{239}$
$= £\frac{720}{239}$;
$= £3\frac{3}{239}$;

$$\therefore \text{Price of consols} = £100\times\frac{3}{3\frac{3}{239}}$$

$$= £\frac{\overset{25}{\cancel{100}}\times 3\times 47}{\underset{12}{\cancel{144}}}$$

$= £\frac{235}{12}$
$= £19\frac{7}{12}$. Ans.

5. GYMNAST.—At what rate per cent., compound interest, will 70 guineas amount to £114 16s. $10\frac{1}{2}$d. in 2 years?

£114 16s. $10\frac{1}{2}$d. $=$ £114·84375 ;
70 guineas $=$ £73·5 ;

Amount of £1 at end of 2 years
$=$ £114·84375 ÷ 73·5
$=$ £1·5625 ;

Now $\sqrt{1{\cdot}5625} = 1{\cdot}25$;
$\therefore$ Amount of £1 for 1 year $=$ £1·25,
" " £100 " " $=$ £125 ;
$\therefore$ Rate per cent. $=$ 25. Ans.

Note.—When the time is 3 years, 4 years, &c., the cube root, 4th root, &c., must be taken. The 5th, 7th, and similar roots would be calculated by Logarithms.

6. ARMY.—The receipts of a railway company are apportioned in the following manner :— 49 per cent. for working expenses, 10 per cent. for the reserved fund, a guaranteed dividend of 5 per cent. on $\frac{1}{4}$ of the capital, and the remainder, £40,000, for division among the holders of the rest of the stock, being a dividend at the rate of 4 per cent. per annum. Find the capital and receipts. (*Matriculation, June*, 1867.)

Dividend of 4 per cent. is paid on $\frac{1}{4}$ of the capital ;

$$\therefore \text{Capital} = £40{,}000\times\frac{100}{4}\times\frac{1}{4}$$

$= £1{,}250{,}000$. Ans.

$$\therefore \text{Receipts} = (£40{,}000 + 5\%\text{ on }\tfrac{1}{4}\text{ of }£1{,}250{,}000)\times\frac{100}{100-(49+10)}$$

$= (£40{,}000 + £12{,}500)\times\frac{100}{41}$
$= £52{,}500\times\frac{100}{41}$
$= £\frac{5250000}{41}$
$= £128{,}048\text{ 15s. }7\frac{1}{41}$d. Ans.

7. A WHARTON.—A hare is 200 of her own paces in front of a greyhound. If 2 of the greyhound's paces are equal to 3 of the hare's, but he only takes 3 whilst the hare takes 4, in how many of the hare's paces will he overtake her? (*Capel's* 'Catch Questions in Arithmetic and Mensuration.')

Greyhound takes 3 of his paces whilst hare takes 4 of her paces,
Greyhound takes $3\times\frac{3}{2}$ or $4\frac{1}{2}$ of the hare's paces whilst the hare takes 4 of her paces,
$\therefore$ Greyhound gains $\frac{1}{2}$ pace in $4\frac{1}{2}$ of the hare's paces,
$\therefore$ Greyhound will overtake the hare in $\{(200\div\frac{1}{2})\times 4\frac{1}{2}\}$ of the hare's paces
$= (400\times 4\frac{1}{2})$ of the hare's paces
$=$ 1,800 of the hare's paces. Ans.

8. MAGISTER.—The issue of certain Railway shares was £50, to be paid in 5 instalments of £10 each, the first payment on application. After a 'call' or second payment of £10, the shares stood at a premium of £1 per share. I then invested £756, and after paying a further call of £10, a dividend of 8½ per cent. per annum on the paid up capital was declared. What is the amount of my dividend, and what interest do I get for my money?

No. of shares = £756 ÷ £21
= 36;
∴ Dividend = 8½ % on (36 × 30)£
= 8½ % on £1,080
= £10 16s. × 8½
= £86 8s. + £5 8s.
= £91 16s. Ans.

∴ Interest = £91 16s. × $\frac{£100}{£756 + £360}$
= £91 16s. × $\frac{100}{1116}$
= £9,180 ÷ 1,116
= £255 ÷ 31
= £8 4s. 6$\frac{6}{31}$d. Ans.

Science Notes.

THE thirty-third report of the Science and Art Department has been recently published. The schedule of drawing as a class subject is printed in full, with the illustrations which were published last May. It is very necessary that all teachers who intend to teach drawing in their schools should see these illustrations. Changes may be introduced, but the lines already laid down are likely to be the outline of instruction for some time to come. The report contains some interesting information in regard to the increasing accommodation for teaching science practically. The radical difference between teaching science and the ordinary subjects of a school curriculum has too long been lost sight of. Special arrangements are necessary, and, where it is possible, special rooms should be set apart for teaching separate subjects. Economy of teacher's time and efficiency of instruction would certainly be promoted. There is no escape from the conclusion that science teaching, to be really valuable, must be expensive. Plenty of apparatus for illustrating lectures is absolutely necessary. But it becomes more and more clearly recognised that pupils must repeat many experiments for themselves if they are to reap the full advantage from the study of natural phenomena. Simple measurements have to be made, and calculations performed, and results verified. All this takes time, and involves the use of apparatus which, though not necessarily expensive, is capable of yielding fair results. It is really surprising how much useful work may be done with a balance and weights, which can be bought for £3. It is in many cases more difficult to find a room with suitable places to use the apparatus, and put it away, than it would be to collect the funds to purchase it with. Young teachers will do well to observe how the current of public feeling is setting. If they are wise they will seek to become thoroughly prepared to give such scientific and technical instruction as they may in future be called upon to impart.

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The Colonial Exhibition seems to be more popular than any of its predecessors. And it is, indeed, an excellent show. It is not specially intended as an educational display. There is no room set apart for science, but science teachers will find many objects of interest. Students of geology will have an excellent opportunity of seeing specimens of the chief minerals found in our colonies. There are splendid specimens of ore from Australia. The processes by which the metal is extracted are shown in detail. This will be a great source of interest to many intelligent scholars, and perhaps to some of the teachers too. We noticed an exhibit for the better teaching of solid and descriptive geometry, by J. M. Pringle. It is No. 80 in the New South Wales collection. It appears well worth examination, as suggesting an improved way of illustrating a rather difficult subject. Teachers might probably learn something from it, even if they did not see the way to adopting it.

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The recent debate upon the presentation of the education estimates for the year was instructive. The feeling in favour of the use of simple tools by the elder scholars is greatly on the increase. Boys who have passed Standards V., VI., and VII., may most profitably spend some of their time in learning how to use some of the common tools. Dexterity is best and most easily acquired in youth. Manual labour is healthy, and exercises a beneficial influence on the powers of observation, and is suggestive and helpful in many ways.

We are sure that elementary forms of technical instruction will become more and more popular with pupils and parents, with teachers and inspectors. It needs time. At present we are only feeling our way.

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Mr. Frederick Chambers has recently written an important article in *Nature* on sunspots and prices of Indian food grains. It is well known that the sunspots are far more numerous at some times than at others. About every eleven years there seems to be a maximum of solar activity. The records of magnetic disturbances afford even more definite indications of periodicity. It also appears from the history of prices of grain in India, that the fluctuations are well marked and periodical. The contention is that the prices of corn and the sunspots are in some way connected. It cannot be denied that there have been remarkable variations in prices, and that these variations have succeeded each other, on the whole, regularly, and in accordance with the sunspot curve. There is reason, the author says, to believe that the period of low prices following the last maximum of sunspots, which appears to have occurred about the end of 1882 or early in 1883, will not last very much longer, a brisk rise of prices being due in the Deccan and in Madras five years after the sunspot maximum, that is, in 1887 or 1888, and in more northern districts a year or two later.

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The *Naturalist's Diary*, lately published for Mr. Roberts, is a most excellent companion to everybody who loves Nature, and would like to know what to observe, and how to record it. We recommend it especially to those who take delight in rambles through the country, and for whom nothing in the world they live in is without interest. This book will afford them hours of delightful work, and will become afterwards a pleasant record of past years, recalling the freshness of the country, and the keen enjoyment derived from personal and careful observation of its ever-varying aspects.

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It is not to be wondered at that the Meteorological Society should have called attention to the severity of the winter we have just passed through. The cold extended from October to March, but it was most marked from January to March. In the weeks ending January 25th and March 1st, 8th, and 15th, the temperature was below the average as much as 10°, and during the first fortnight in March the mean temperature was below the freezing point in the Midland counties. In the first three months in the year there was frost on sixty nights. The most striking feature in connection with the cold winter was the lowness of the temperature at the beginning of March. 1814 and 1845 are the only two years this century in which the cold has been so intense in March. The logs of ships show that the abnormal condition which prevailed in the British Isles extended considerably to the westward. There was a tendency to a low barometer where a high one is usual, and to the north of this low barometer area strong and persistent N. and N.E. were experienced. Thus the usual conditions were, to a great extent, reversed, and it is very likely that to these changed conditions the exceptional severity of our winter was very closely related.

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The 'Practical Teacher' Sale and Exchange Column.

Owing to numerous requests, we have been induced to start this Exchange Column for the benefit of our readers. We shall be glad to insert announcements relating to the 'Sale or Exchange' of books, etc., at the rate of ONE PENNY PER LINE, *prepaid.*

For Sale:—Muir's Arithmetic, 4s. 6d.; Cassell's Guide to Employment in the Civil Service, 3s. 6d.; Loudon's Elements of Algebra, 2s. 6d.; Atkins' Pure Mathematics, Vol. I., 2s. 6d.; Webster's The Steam Engine, and Steam, 2s. 6d.; Griffin's Algebra and Trigonometry, 3s. 6d.; Notes on Griffin's Algebra and Trigonometry, 3s. 6d.; Lewis's English Language, its Grammar and History, 3s.; A Complete Atithmetic, with Answers, 1s. 6d. Any of the above post-free at half price.—Teacher, Ford End School, Chelmsford, Essex.

For Sale:—Letts' Popular Atlas, folio edition, half morocco, cost 12s. 6d., sell 5s. 6d., not been used; Cassell's Saturday Journal, Vols. I. and II., handsomely bound in case, 3s. each; The World as it is, 6 parts, cost 2s. each, sell 6d. each; Map of Europe, 6 feet square, new, cost 17s. 6d., sell 10s.—Apply Sidney Savile, 75, High-street, Bridlington.

What offers? PRACTICAL TEACHER, Vol. III., No. 10; IV., all except No. 7; V., all but No. 4; VI., Nos. 1, 2, 3; all in good condition.—W. Hutchins, 37½, S. Ebbes-street, Oxford.

For Sale:—Blackie's Encyclopædia, 70s.; Wellington's Campaigns, 12 divs., cloth, 25s.; Ansled's Physic. Geog., 3s. 6d.; Carpenter's Physiology, 2s. 6d.; Currie's School Man, 3s.; Initia Græca I., 2s.; Popular Educator, 21s.—Schoolmaster, Norham-on-Tweed.

Wanted:—London University Calendars, 79, 80, 81, will give 2s. for any one; and 1st B. A. Guide, by a Private Tutor. For Sale:—Dublin Calendars, 82, 86; Royal Irish, 84; Roscoe's Chemistry, 2s.; Gile's Keys (new) Euripides Medea, 1s. 6d., and Horace's Odes and Epodes, 1s. 6d.; Oxford Classics: Homer's Odyssey (3), 1s. 6d.; Valpy's Horace (3s. 6d.), 1s. 3d.: Science and Art Prize Microscope (10s. 6d.), 5s.—Address H. G. Wright, 1, Little Templar-street, Leeds.

Publications Received.

Blackie and Son—
Algebra for School and Science Classes. By J. G. Kerr M.A.
Poynter's Drawing Cards, Standards I. and II., Sets A and B; Standard III., Sets A and B; Standard IV., Sets A and B.
Commentaries for Bible Classes.—The Gospel of St. Luke, with notes, &c. By T. M. Lindsay, D.D.

Curwen J. and Sons.—
Robert Moffat. A Biography, with Musical Illustrations.
How to Earn the Music Grant. By an Inspector of Schools. (Staff Notation.)
Training College Music Tests, in Time, Tune, and Ear. By J. Thomson, M.R.A.M.

Heywood, John—
Examples of Machine Construction Drawing. Books 1 and 2. By Thomas Jones.
School Management and Method. By J. J. Prince.

Johnston, W. and A. K.—
Natural History Plates—The Chimpanzee—The Fox.
Types of Nations—The Hindu.

Laurie T.—
Suggestion for Establishing Cheap, Popular and Educational Museums.
Education in its Physical Relations. By W. Jo'l, H.M. Inspector of Schools, F.R.S.E., F.G.S.

Marshall, J. and Co.—
The Explanatory English Grammar and Poetry. Sets 1 and 2, 3, 4 and 5. By Charles Shuter.

Smith, Elder and Co.—
The Cornhill Magazine. June.

T. Fisher Unwin.—
The Story of The Nations. *Rome.* By A. Gilman, M.A.

The National Society's Depository.—
The New National Copy Books, Nos. 1 to 14.
Notes of Arithmetic Lessons.
The New National Reading Book, Primer, Infant Reader, and Standards I. to VI.

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Publications Reviewed.

Ablett's Drawing Copies. Demonstration Sheets: Sets VI., VII. and IX. London: Blackie and Son.

The three sets of Demonstration Sheets under review form a continuation of Messrs. Blackie's New Drawing Series, part of which have already been noticed in the *Practical Teacher.* They are in every respect equal to the former sets. No. 6 contains eleven examination tests for Standard III. With one exception these tests are eminently suitable and not too difficult. No teacher need complain that his work has been unfairly tested if, under the new conditions, his children have no more difficult copies than those here given. In No. 7 the Freehand copies are for Standard IV., and in Set 9 they are for Standard V. Guiding lines are shown in several of the copies, which are enlarged in some cases to three, and in others to four times the size of copies contained in the books provided for the use of the scholars. The subjects are continuations and combinations of the curves taught systematically in former sets applied to common objects and ornament. There is not a copy in these sets which does not illustrate in a greater or less degree what has been previously taught. When it is possible to provide both Demonstration sheets and books the Class Subject 'Drawing' need not be dreaded by any teacher who can find sufficient time for the work among the multiplicity of subjects already asked at his hands.

Blackie's Arithmetical Test Questions: Standards II. to VII. London: Blackie and Son.

Messrs. Blackie and Son have published under the above title a well known series of Test Cards in book form for each of the Standards from the second upwards. There are twenty-six tests in each book, each test consisting of six sums. The examples are so arranged that those of the same rule occupy the same position in every set. The books may therefore be used for class teaching, as well as examination purposes. Considerable variety, practical examples, and average difficulty are the distinguishing features of these Arithmetical Test Questions.

Poynter's Drawing Cards for the Standards: Sets A and B. Standards I., II., III. London: Blackie and Son.

These Cards have the advantage of containing all the examples included in the syllabus issued by the Department to accompany the new Drawing Minute; and other examples from Dyce's Drawing Book and the South Kensington Drawing Book prepared by Mr. E. J. Poynter, R.A. The first two of the sets under review are for use in Standards I. and II., and the second two for use in Standard III. Each set consists of twelve stout cards printed on both sides. The subjects are graduated and not too difficult. Directions to aid the teacher are printed by the side of each example, and as he is advised to use the blackboard freely, these will be of service when the copies are taken for class teaching purposes. The sets may be used with advantage solely, or as an alternative series to the valuable series noticed previously in these pages.

Algebra for Schools and Science Classes: By John Guthrie Kerr, M.A. London: Blackie and Son.

The distinctive feature of this Algebra is the way in which explanation and examples are combined. The steps taken are easy and carefully graduated. A pupil might take up the book and almost without the aid of a teacher, go through it from beginning to end. It includes all that is necessary for any examination in Elementary Algebra up to and including Quadratics, Progressions, Ratios, and Scales of Notation. The explanations are remarkably clear and concise, and the examples varied and plentiful. We have had great pleasure in examining the work, and can cordially recommend it.

The Teacher's Handbook of Psychology. By James Sully, M.A. London: Longmans, Green, and Co.

Professor Sully has done an immense service to Education by the publication of this volume. Teachers and students in training have, in this work, a lucid and simple exposition of the elements of Mental Science in their bearing on the work of training and developing the minds of the young.

The material of a former volume, 'The outlines of Psychology' (which received high commendation in a former number of the *Practical Teacher*), has been reduced and simplified, and the practical application of the scientific principles therein enunciated has been considerably expanded.

Professor Sully sets out with the statement that 'Education seeks by social guidance and control to develop the natural powers of the child, so as to render him able and disposed to lead a healthy, happy, and morally worthy life.' The life effects here stated are felt to be somewhat vague and uncertain, and in the estimation of many would be incomplete. Professor Sully, recognizing this, afterwards allows the aims of Education to be enlarged so as to 'include the development of those religious faculties and emotions, the exercise of which constitutes man's highest function, and the direct preparation for the larger and enduring after life.' Coming more particularly to the immediate object of school work, the volume before us for the most part deals with:—

(1) The formation of faculty rather than the mere communication and acquisition of knowledge.

(2) The growth of self control and the development of a well ordered and disciplined life.

In working out a series of intellectual operations for the exercise and development of faculty the author is singularly clear. Teachers who have regard to the development of the mind and the exercise of its various activities rather than the amassing of large stores of facts, will study these pages with delight, and long for the time when they shall be free to apply the principles—illustrated and established by Professor Sully—in the daily round of school work and life.

In school discipline scarcely sufficient credit is given to the power of numbers either in regulating the conduct of individuals or as a controlling agent over the mass. We heartily commend this work to the attention of all who have the training of children either in hand or at heart.

How to Earn the Music Grant. By an Inspector of Schools. Curwen: London.

An excellent and useful little book, containing complete information and a well-graduated course of specimen tests and exercises. It may be used alone, or in conjunction with 'Code Singing Tests' (Evans and Tosh), which we noticed in these columns last month. The teacher who desires to give his pupils a thorough drill, and seeks variety, cannot do better than to use both books. The book before us is carefully compiled, clearly printed, and inexpensive.

Training College Music Tests in Time, Tune, and Ear. By J. Thomson, M.R.A.M. Curwen: London.

Mr. Thomson, who is the Professor of Music in the Homerton and Saffron Walden Training Colleges, has been enabled by his long experience to anticipate the difficulties which are likely to occur in connection with the Practical Examination of Second Year's Students. The passages given throughout the book are varied and comprehensive; they are, of course, somewhat in advance of the work actually expected of students, but we may safely predict that those who are able to master the tests here given will be prepared to pass an 'Excellent' examination. This is the best and cheapest book of the kind that we have seen, and we confidently recommend it to all those for whom it is intended.

The Oriel Atlases. Standards V. and VI. London: Marcus Ward and Co.

These atlases are prepared specially for the work of the standards. They are cheap and contain an abundance of geographical information. The names are well printed and the colouring is attractive. The names might with advantage be reduced to quite one fourth, and greater prominence given to variety of contour by the use of hachures in shading. Our atlases must abandon more completely the *plan* idea and follow the relief contour maps of Belgium and France. In the map of Victoria there are no less than 45 names crowded in a single square inch of space. Amongst these along the coast are the following: C. Liptrap, L. Wellington, L. King, Ram Hd., Green C., C. Dromedary, and Bateman Bay. None of these will be needed either for examination purposes or for reference. What educational purpose can such unimportant facts serve. Their admission into our atlases only serves to confuse the learner and to obscure the more important facts of geography.

Infant School Management. By Sarah J. Hale. London: Edward Stanford, 55, Charing Cross, S.W.

These Notes of Lectures delivered to the Students of St. Katherine's College, Tottenham, abound in suggestions of the highest practical value. They are the outcome of much experience in school keeping, guided and enlightened by a knowledge of the principles upon which sound methods are based. The infant school teacher will look for guidance from so experienced an authority in the newer branches of her work. The chapter on 'Simple Lessons on Objects and on the Phenomena of Nature and Common Life,' contains many valuable hints as, *e. g.*, 'Fragmentary scraps of knowledge are, by reason of their disconnectedness, of little value. The teacher must make out a *plan of lessons* in which the subjects follow each other in due sequence.' We quite agree that this condition is of prime necessity in any system of object lessons submitted for the approval of Her Majesty's Inspector. A list of lessons follows, arranged with special view to make the lessons link together: We quote the following examples:—

(1) Bread (2) Wheat plant (3) Cultivation of wheat.
(1) Milk (2) Manufacture of Butter (3) Cheese making.
(1) Woollen clothes (2) The sheep and sheep shearing (3) Manufacturing processes of wool.

The system of linked lessons, of which the above are samples, is followed by some admirably practical hints upon their use, from which we select the following:—'It must be borne in mind that the chief end of these lessons is not so much to convey information as to train the children to observe and find out things for themselves, and therefore they must be constantly encouraged to tell what they have seen of the object before, and as much as they can of what they now observe respecting it. Do not talk to them so much as help them to talk to you, for another end of the object lesson is to assist in the acquisition of language.'

This is excellent advice, and we trust that under an enlightened inspectorate every infant teacher will be encouraged to follow it.

Amongst so much that is excellent and which demands generous recognition we would suggest the introduction of the method of equal addition in the process of teaching subtraction and a more systematic arrangement of the simple characters in teaching writing.

Interrupted. By Pansy. London: Hodder and Stoughton.

This is a reprint of an American book of a somewhat advanced religious type.

When we use the term advanced, we don't by any means wish to convey that it is advanced towards Ritualism or anything of the kind; indeed, the small place of worship which figures in such a marked way in the book can scarcely belong to the Episcopal Church of America, though we are not told to which of the numerous sections of Christianity it does belong.

The story begins by introducing us to one of those strong-minded young women who not only do a great deal themselves, but by their energy and organising powers manage to get a great deal of work out of others who, without such a guide, would do little or nothing.

Her work in the great city is 'interrupted' by the sudden death of her father, of whose wisdom and goodness we have only a glimpse, and the loss of means to admit of an idle existence.

After refusing to earn money with her beautiful voice at a place of worship, where the doctrines taught were not in accordance with her faith, she goes into the country some 200 miles away, to teach music at a very second-rate academy.

Here she finds a dirty, neglected, badly-served, and almost deserted church. Some stranger preaches and she becomes convinced that it is her work to beautify this place, and in doing so, to do good to others, and especially the girls under her care.

Gradually volunteers, both male and female, come in, and the place becomes changed, and the young people find a new interest in life—the means employed being very un-English.

We constantly hear the heroine asking those with whom she comes in contact, old and young, male and female: 'Are you a Christian?' and it is very evident that the authoress depicts her heroine as utterly ignoring anything of the nature of baptismal grace.

This question of 'are you a Christian?' was much the same as the one we heard many years ago asked so often in this country, before the great Catholic wave of thought swept over the land, viz., 'Are you converted?'

We are not surprised to find the heroine very strong on the subject of total abstinence. A young man comes to learn a song with her. She perceives he has been taking a little wine,—out comes her total abstinence pledge book and an entreaty to him to sign it there and then. After a long and not very forcible conversation, she succeeds in getting from him the funny written promise to tell her within twenty-four hours every time he touches alcohol. We trust sincerely that such requests amongst young apostles of temperance will not become common in this country.

A young man appears on the scene and all ends happily.

We can understand the book being useful to young ladies who do too much in what may seem a good cause, neglecting more prosaic duties, and to those who do too little.

We are bound to add that we believe that there are thousands and thousands of useful people who do their daily round of duty as such, who yet would hesitate to answer in the affirmative such a question as 'Are you a Christian?' according of course to the meaning intended by the heroine of the work before us.

The Lost Silver of Briffault. By Amelia E. Barr. London: Hodder and Stoughton.

This is another reprint of an American work, with a very decided religious tone, but of a much healthier and more manly kind. The time of the story is just after the war between the North and the South.

The first scene of a young girl telling the slaves they were free, is graphically told, and their broken promises of fidelity unhappily true to the life.

The real heroine of the book is an old woman, who is first introduced to us as one of almost diabolical tendencies. In the course of the book, however, she is gradually brought under the influence of religion, and we leave her a happy, joy-spreading old lady, delighting in her children of the third generation.

Though the book, as we have said, is decidedly religious, the novel lover will find plenty of incident and excitement, not to say sensation of a most marked kind.

The authoress evidently believes that demoniacal possession is as possible in the nineteenth century as in the first, and that nothing but a Power from on high can dispossess such.

We don't know that the book will be of much use to sober-minded English young men and women, as happily the characters are not typically English.

Comrades. By Sarah Tytler. Messrs. Hodder and Stoughton.

Here we have a third volume, of a very decided religious tendency, but not written by an American.

The comrades, who give the title to the book, are three young men who are possessed with an all absorbing passion to become foreign missionaries of the Gospel. The time of the story is when the great Indian Mutiny was preparing and in action. The authoress tells us of the state of mind in Scotland with respect to missionary zeal which was in existence at that time. At the commencement of the story we are introduced to a brother and a sister, just about to leave their old home. The brother had two college friends, who were also strangely

attached to each other, as perhaps only such perfect opposites of character could be attached. One of these friends, the real hero of the book, is one of those very bright specimens which the system of Scotch university education could alone make possible, viz., one who has had his bodily strength cultivated by hard manual labour, in part of the year, while his intellect had been cultivated in the other months. He is depicted, therefore, as both rough, uncouth, but good and clever. The other was one brought up in the lap of luxury, with all that this world can give him, excepting health and strength.

The weaker of the two is offered on the same day two clerical appointments, the one an important station in Afghanistan, and the other a mission in Scotland itself with a comfortable manse.

After a great battle with himself, he feels that he is more fitted for the quieter sphere, and gets his friend appointed to the more dangerous and exciting one.

After this mighty sacrifice of all his hopes and highest ambitions, he finds too that his humbler stronger friend has more charms in the eyes of the sister, mentioned above, and whom he had hoped to make his wife. He happily finds this out in time, so that not till the very end is it known to her that he cared for her, except as a friend.

The brother soon disappears from the book, dying in the early days of his missionary career.

The rest of the book follows these two good men in their respective labours, and the moral we gathered was that it was quite possible to do as much good at home as abroad, though no doubt this particular missionary was wonderfully blessed in his work, for which his widow and children were duly rewarded by a grateful nation.

The book is written in Miss Tytler's usual charming style, and the information on Scotch missionary work is valuable. We heartily commend it.

It would be exceedingly unfair to the publishers not to add a line as to the get-up of these three volumes. The covers are really beautiful, and the printing as good as it is almost possible to imagine.

A New Easy Latin Primer. By the Rev. Edmund Fowle. Swan, Sonnenschein, Le Bas and Lowrey, Paternoster Square, 1886.

It was the glory and boast of the late Dr. T. K. Arnold that he had made school books attractive. Under his humane system of explanation and encouragement the pupil was to be brought out of 'the wearisome bitterness of his learning.'

The Rev. Edmund Fowle may or may not be a second Dr. Arnold, though like him he is an instructor of youth both by speech and writing, but the aim and end of his books is certainly to simplify the acquisition of learning, and smoothe the path of the beginner. The little book before us will certainly be welcomed by many to whom the Public School Latin Grammar is an object of aversion not unmixed with awe.

Whether or not the complete removal of all difficulties from the path of the learner be an absolutely proper ideal, may admit of some diversity of opinion, but, while perfectly willing to admit that the mind may be weakened by overmuch assistance, we can hardly find fault with an expositor for being too luminous, neither can we admit as an excuse for want of clearness, or for a 'dryness' which is found in practice to repel the learner, the fact that it is desirable to leave the mind something to grapple with.

The difficulties which the student ought to be left to face are, we think, those of the subject matter rather than of the style in which a treatise is written.

Unorthodox as this sentiment may appear, we are sceptics with regard to the infallibility of the Public School Latin Primer. Without going quite so far as Professor D'Arcy Thompson, who speaks of it, if we recollect the precise words, as the 'orthodox manual of darkness,' we nevertheless think the book about as unfit to be put into the hands of a beginner in Latin as the wit of man could devise, and if the beginner be dull and stupid, with no inherited capacity for the absorption of the dead languages, the case is still worse. Strange to say, while the work is entitled 'the Primer,' and in spite of the fact that it is used as a 'First Book' in hundreds of English schools, the present preface naively admits its unsuitableness as a First Book in Latin, and recognises that it is, what everyone who knows the book would be inclined to call it, 'a concise manual of facts and code of rules in Latin.' The book contains as much, perhaps, as could possibly be compressed into the same number of pages, but for all that, its style and arrangement are not what is required for beginners.

Mr. Fowle's book is the very opposite of the Primer. It aims from the very first at being easy, straightforward, and intelligible.

We are glad to notice that the author gives the 'cases' of nouns and adjectives in full, even when two or three happen to be alike. Who that has ever taught a class of beginners in Latin, can doubt that the pupil's ideas are all the clearer for having every case symmetrically arranged before him? It is not enough to tell him that the Nominative, Vocative, and Accusative are alike—he wishes to see them before him, and to take note of their similarity. Practical teachers find it the best plan to write down every case in full.

A great fault of the Primer is that the 'exceptions' are so numerous and are introduced so early.

The 'Anomalies of the Noun' have caused the beginner many a headache, and the chapter on the Gender of nouns is enough to strike the stoutest youthful heart with terror.

In Mr. Fowle's book most of this sort of thing is reserved till the learner has run the length of the regular forms, being grouped together at the end in the part called 'Difficiliora.'

All through Mr. Fowle's book we meet with great clearness of expression and arrangement. Some of the paragraphs look as if they had been framed for the express purpose of being committed to memory, and would score extremely well if reproduced in an examination. The 'rule for writing compound numbers' (p. 23), the distinction of the Four Conjugations (p. 36), the account of the Four Participles (p. 37), the constructions after the Impersonal Verbs (p. 53), and the four undeclined parts of speech, (p. 64), are all admirable specimens of this style of writing.

Indeed, the whole arrangement of the book is so beautifully clear that we fancy the pupil will gain from it, besides the knowledge of Latin which it is primarily intended to impart, some exceedingly valuable lessons in the arts of condensation and arrangement of subject-matter, which will leave their stamp on the mind long after the Latin has been forgotten.

The type of this book is exceedingly clear, and the paper unusually thick and good. We almost fancy, notwithstanding the barbaric tastes of schoolboys, that they must occasionally feel a pang of remorse after they have yielded to the temptation to deface or destroy a book of this description. It looks so very nice that many of its juvenile possessors will be induced, we hope, to take care of it and keep it clean.

The style of the Easy Latin Primer though simple is at the same time dignified. There are no traces of that type of explanation which we may designate as the 'over familiar,' a sort of style based upon a supposed necessity of 'talking down' to the level of the learner's comprehension, and which defaces many of our modern text-books. There is scarcely, in fact, a sentence that we should desire to see re-modelled merely on account of its style, except possibly one or two such things as 'to conjugate a verb *a boy* must know the stems of the Present and Perfect' (p. 35)—why a boy only? 'The following *sample* Adjectives are declined, (p. 20), and 'One very important thing *for a boy* to remember is. (p. 93). Mr. Fowle's English, besides accuracy, has the further merit of good taste.

Part II. (Syntax) teaches many rather difficult rules with the smallest possible recourse to that abstract phraseology which is the glory of the Latin Primer, and the stumbling block of the primer-taught beginner. We have failed to detect, at all events, on a cursory inspection, any reference to those brilliant generalisations 'Trajective verbs,' 'Ablative of quality with epithet,' 'Cases out of the subject,' 'Gerundive Attraction' and 'the figure called Synesis,' and believe that Mr. Fowle has managed somehow to teach Latin syntax without them. We scarcely think it was necessary, however, when printing 'verbs which take either of two cases,' and 'verbs which take a double case' in the biggest of big capitals to underline any portion of these expressions. Mr. Fowle attacks difficulties in a manly fashion, and when so doing is not sparing of the words necessary for a complete elucidation. We have never seen the Gerundive construction so well explained (p. 99), and if any shadow of doubt should remain in the mind of a student who has studied the explanation here given of the 'Accusative and Infinitive' (pp. 101-2), the Subjunctive after *qui* (p. 104), or the distinction between *hic*, *ille*, and *iste* (p. 111), we feel sure that the fault must be sought for in the brain of the reader and not in the wording of this text book.

Part III. contains the 'Irregular Verbs,' and

Part IV. '*Difficiliora*.' The hundred and one peculiarities of the erratic nouns which are generally given at first, are thus reserved for the end of the volume.

Mr. Fowle, we presume, would teach his scholars all the five declensions thoroughly, and if we understand him aright, the outlines of adjectives, pronouns, and verbs also, before he would trouble their minds with the fact that *acus* and *anus* are of the feminine, *pelagus* and *virus* of the neuter gender. Nor would he just at first afflict their sensibilities with the peculiarities of nouns Heteroclite and Defective. This is a sound principle very possibly, and we wish that it was recognized in juvenile Examinations, which should be based upon some principle which would allow the simple and regular to precede the irregular and composite. We heartily wish, too, that words which the student is never likely to meet with in the classical authors were kept out of the grammar. Where, by the way, did Mr. Fowle pick up *Zingiber* (ginger)?

On the whole, Mr. Fowle may claim to have produced a book which contains, we imagine, all that is most valuable in the Public School Primer, expressed in a manner that is neither repulsive nor discouraging, and which, by its clearness and perspicuity is calculated to charm both teachers and pupils. The term 'Primer,' in fact, rather underrates the efficiency of the book, for though it would serve well enough for a first book in Latin, it contains a great deal more than is required by the beginner. We feel inclined to say to the author '*Macte virtute esto*.'

Owing to pressure on our space this month we are reluctantly compelled to hold over several Reviews, as well as Elements of Mental and Moral Science, and Popular Mythology.

We hope to be able to announce in our next issue the list of Successful Competitors in the 'Ten Guinea Writing Competition.'

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